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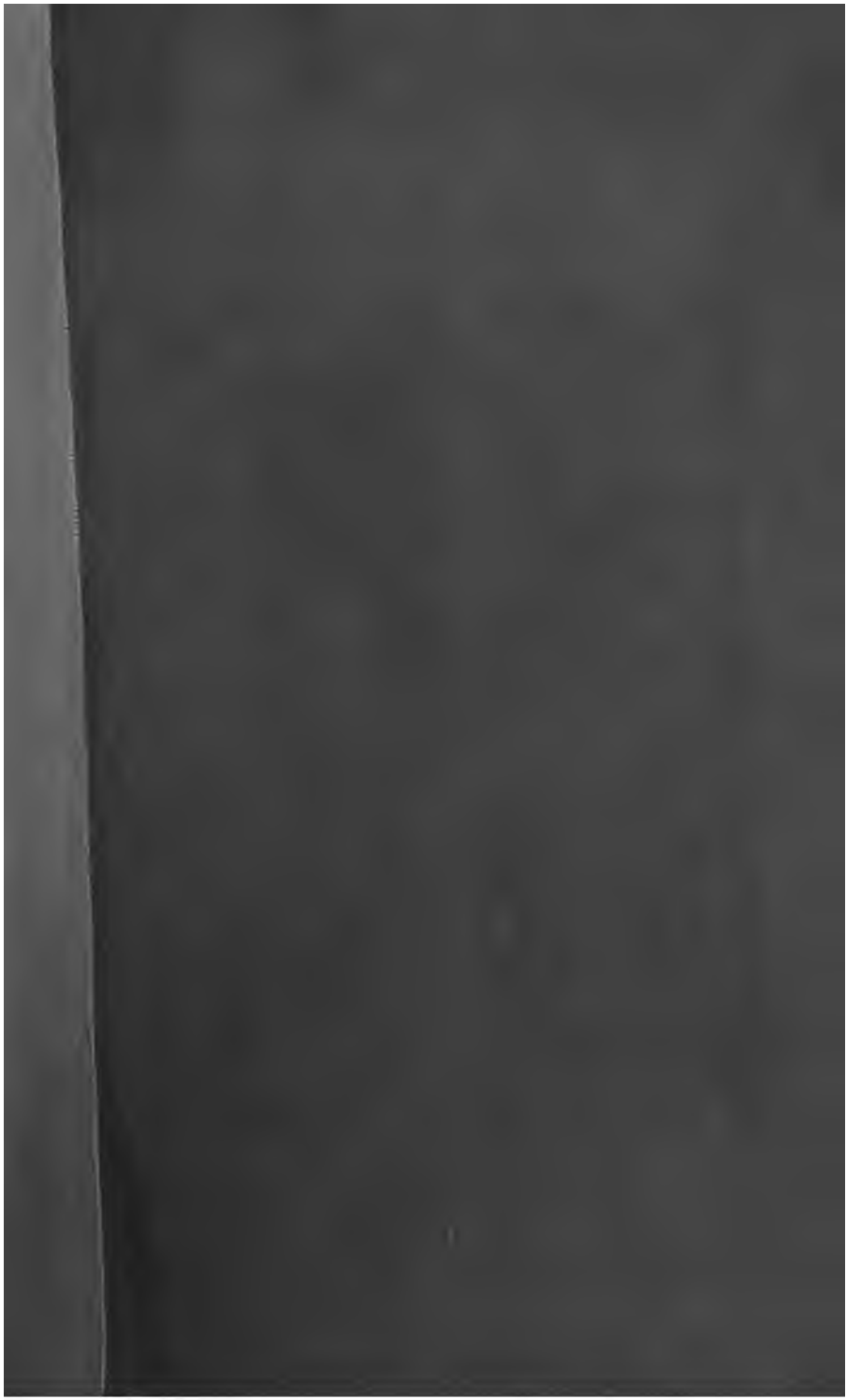

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MONTHLY NOTICES

OF THE

ASTRONOMICAL SOCIETY OF LONDON,

CONTAINING

ABSTRACTS OF PAPERS,

AND

REPORTS OF THE PROCEEDINGS

OF

THE SOCIETY,

FROM FEBRUARY 1827, *TO DECEMBER* 1830.

VOL. I.

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ASTRONOMICAL SOCIETY OF LONDON.

February 9, 1827. No. I.

Report of the Council of the Society to the seventh Annual General Meeting this Day.

SEVEN years have now elapsed since the formation of this Society: during which period, it must be evident to every intelligent observer, that a considerable progress (assisted, it is hoped, by the exertions of this Society) has been made in the science of Astronomy, not only in our own, but in every other country. The increased number of observatories, and the consequent encouragement which is given to the improvement of astronomical instruments,—the zeal and assiduity, not only of the public observers, but also of many private individuals, who nobly sacrifice a great portion of their time and fortune to this laudable pursuit,—prove that the science is now more generally followed and encouraged than at any former period.

To enable the Society to continue its assistance in preserving and promoting this favourable change, the Council rely on the cordial co-operation of all those members who have the means in their power, of conducing to this grand end. Those even, who have only *small* instruments in their possession, may still do much good, by a careful and judicious use of them: for although every astronomer must admire the vast field that has been opened by the powerful and splendid telescopes of Messrs. Herschel, South, and Struve, and the patience and skilful assiduity of these observers, yet we ought not to lose sight of those innumerable aids which may be rendered to astronomy, by more humble instruments, nor of the assistance that may be afforded to the *physical* and other departments of the science by those who are not possessed of any instrument at all.

In the last Report of the Council it was stated, that a letter had been received from M. Bessel, relative to a plan for a general survey of the heavens, and for making detached charts of the same. The *prospectus* relative to this subject was translated and distributed, not only amongst the members of this Society, but also amongst such other astronomers, as might be supposed desirous of encouraging so useful and important an undertaking. Two applications were made from this country, to the Committee at Berlin, appointed to superintend the distribution of the allotments: but, it is doubtful whether more than *one* of them can be appropriated here, as it is understood that the rest have been, or probably will be, taken up by different astronomers on the continent.

The Council regret that all the various prize questions, that have from time to time been proposed by the Society, still remain unanswered: the period having expired for the determination of the whole of them; except that which relates to the moon's place, which will not terminate till Feb. 1st, in the ensuing year. How far it may be expedient to renew them, or to substitute others, will depend on the views entertained on this subject by their successors in office.

The new tables for computing the Aberration, Precession, and Nutation of 2881 principal fixed stars, together with a catalogue of the same, are now completed, and have been some time in the hands of the public. This important work was first suggested, and the formulæ for the computations were investigated and practically arranged, by F. Baily, Esq. your indefatigable President, who, agreeably to the Regulations of the Society, resigns the chair this day. Much of the time and labour of the computers, engaged in this extensive work, was saved, and the liability to error very much abridged, by the use of printed *skeleton forms*, which he had constructed expressly for their use, from formulæ reduced to the most simple and convenient shape for calculation. The work itself has been brought to a successful termination by the extraordinary diligence, activity, and perseverance, of Lieut. Stratford, of the Royal Navy, one of your Secretaries; who in the midst of his other various avocations and duties, has been unremitting in his attention to promote the progress and secure the accuracy of this highly useful work: and who is entitled to your best and most cordial thanks for such a devotion of his time and labour. In fact, the Council, desirous of expressing their sense of the benefit conferred on the science of Astronomy by this important undertaking, have awarded the gold medal to Mr. Baily: and the silver medal to Lieut. Stratford, for the service rendered by these gentlemen in the promotion and completion of the work. May we hope that some experienced astronomer will now take up this new catalogue, and make a series of observations on *every* star contained therein, whereby we may be enabled to ascertain more correctly the proper motion (if any) that should be attributed to each star: and thus deduce a *Fundamental Catalogue* that may assist astronomers for many years to come. The expense of computing and printing this Catalogue has encroached on the ordinary funds of the Society: and has induced many members to suggest the propriety and advantage of defraying the expense not only of this, but of any similar undertaking by means of a separate subscription amongst the members. Should a measure of this kind be recommended, the Council trust that it will meet with the support of every friend of Science.*

The Council, bearing in mind the objects which it is the wish and desire of the Society more particularly to promote, have also awarded the silver medal to Col. Beaufoy, for his valuable collection

* The subscription was immediately set on foot, and met with very considerable support. The list of subscribers is in the hands of the Secretary, and may be seen by any of the members.—*Sec.*

of observations communicated from time to time to this Society, and more especially those relative to the Eclipses of Jupiter's Satellites. Part of this collection has already been published in the Memoirs of this Society; and the remainder will appear in the ensuing volume. These observations seem to have been made with great care and diligence, and afford another, and a powerful instance, how much the science of astronomy may be benefited by the active exertions of *one* individual. Phenomena of this kind cannot always be observed at the *public* observatories: the state of the weather, or more important avocations, may oftentimes interfere to prevent it. It is in such cases, and in numerous other instances, that *private* observers may render an important benefit to the science by their active co-operations.

These several medals to Mr. Baily, Lieut. Stratford, and Col. Beaufoy, will be presented at a subsequent general meeting of the Society, to be convened for that express purpose.

The past year has been abundant in the discovery of comets; no less than five having been announced at the last meeting of the Society. One of these was discovered by M. Gambart, the celebrated astronomer at Marseilles; who, on computing its elements, found that, in all probability, it would pass over the sun's disc on the morning of the 18th of November. He immediately adopted measures for communicating the result of his calculations to all the astronomers in Europe, in order that they might witness this remarkable appearance. But, unfortunately, the whole of that day was cloudy: and it does not appear that this singular phenomenon was witnessed by any human being. To M. Gambart we are also indebted as one of the discoverers of another comet, which appeared in the month of March; and which has since been found to be *periodical*. This comet had been previously seen by M. Biela, at Josephstadt; and M. Clausen, on computing its elements, ascertained that it was the same as that which was seen in 1772, and again in 1805. It is remarkable that both M. Biela and M. Gambart had, in the mean time, come to the same conclusion, from the elements deduced from their own separate and independent observations; thus confirming the addition of another revolving comet to our system, whose period is about 2461 days, or about twice the period of the celebrated comet of Encke. This new planetary body will make its appearance again about the latter end of the year 1832; and the attention of astronomers will then be naturally directed towards its return. If the comet of 1786 bear the name of Encke, this new revolving comet ought, for a similar reason, to bear the name of that astronomer who may most effectually succeed in investigating the laws by which it is governed. It is but a just tribute of respect to men who, by their assiduity and talent, thus enlarge the bounds of science, and add to that vast mass of facts which are absolutely necessary to enable us to judge of the true system of the universe.

In the last part of the Memoirs of this Society, is a Report from the Committee appointed to examine the telescope whose object-glass was formed of the glass presented to the Society by the late

M. Guinand. The object-glass being finished and approved by the Committee (whose report will be seen in the last volume of the Memoirs), it was thought advisable that it should be offered for sale to any of the members of the Society, that might be disposed to bid for it: and that the proceeds, after the payment of expenses for working the glass, should be transmitted to the family of M. Guinand, for their use and benefit. This has been done: and the object-glass is now in the possession of the Rev. Dr. Pearson, the Treasurer of this Society.

With respect to the finances of the Society, it will appear from the report of the Auditors, which has been read, that there have been elected 11 new Members, and 3 Associates, since the last anniversary; and that the Society now consists of 212 Members, and 32 Associates:—in all 244. At the same time it will be seen, that considerable expenses have been incurred in printing the last volume of the Memoirs: which, however, contains a considerable quantity of matter that must be interesting both to the theoretical and practical astronomer.

Amongst the losses by death, which the Society has sustained in the year just past, the Council have to regret those of three of its distinguished Associates: MM. Bode, Fraunhofer, and Piazzi. The first has been long known, not only as the able conductor of the Ephemeris published annually at Berlin, (a work which, for many years, tended more than any other, to promote the advancement of astronomy, by the circulation of important and useful information, on various branches of the science,) but also as the author of several valuable works conducive to the same end; amongst which, his Catalogue of 17,240 stars, (reduced from the observations of various astronomers), and his charts of the same, may be considered as the most important. He died at the advanced age of 80 years. M. Fraunhofer has long been celebrated as a distinguished optician, and as an artist of the first class. Few of the specimens, however, of his superior talent have reached *this* country; but on the continent, where they are more numerous, their value is highly appreciated.

M. Fraunhofer, though not an astronomer himself, has the strongest of claims to the respect and gratitude of astronomers, in furnishing them with means of discovery, in which the most exquisite skill in point of practical execution was directed by the utmost refinement of theoretical knowledge. He was, in the highest sense of the word, an optician, an original discoverer in the most abstruse and delicate departments of his science, a competent mathematician, an admirable mechanist, and a man of a truly philosophical and scientific turn of mind.

Raised by his extraordinary talents from the lowest station in a manufacturing establishment, to the direction of the optical department of the business in which he originally laboured as an ordinary workman, he applied the whole power of his mind to the perfection of the refracting telescope. Easily mastering the refinements of its theory, he saw with regret, that they were for the most part unavail-

able in practice, for want of precise knowledge of the optical properties of the materials used. This he set about to remedy; and by a series of admirable experiments (of which it is impossible in a report of this nature to give any idea), succeeded in giving to optical determinations the precision of astronomical observations, surpassing in this respect all that had gone before him, except perhaps, his great predecessor, NEWTON. He had, it is true, advantages in these researches (such as neither Newton nor any other experimenter has ever possessed), in a command of apparatus limited only by his own inventive powers. It was in the course of these researches, that he was led to the important discovery of the dark lines which occur in the solar spectrum. In this, indeed, he was in some degree anticipated by an illustrious countryman of our own, to whose powers universal science bears grateful testimony. But it is certain that he had no knowledge of the facts thus previously ascertained, and that he pushed his discovery to a point very far beyond them; being aided in so doing by possessing the happy secret of manufacturing flint glass of perfect homogeneity. Whether he originally invented this process, or procured it from another, this is not the occasion to pronounce; but at least his own distinct assertion, that he brought it to its final state of perfection, and to a certainty of manipulation by his personal investigations, ought not to be doubted. Nor did he suffer the secret to lie idle or useless,—his telescopes are scattered over Europe; and his last splendid performance has already demonstrated, by the results it has afforded, his claims to unbounded admiration as an artist. The mechanism employed in the working of his glasses, his mode of centering and adjusting them, and every other part of his processes (the fabrication of his glass only excepted), has been witnessed by more than one member of this Society. It bore the stamp of all his works—simplicity, regularity, and incomparable neatness and precision.

Of his other valuable experiments and discoveries in physical optics, connected with the interferences of the rays of light, (in all of which, though pushed far in advance of the actual state of knowledge, he appears to have relied entirely on his own resources, and drawn little from others,) as less connected with astronomy, it is not necessary here to speak. He died at a premature age: his death being accelerated, it is said, by the unwholesome nature of the processes employed in his glass-house; leaving behind him a reputation rarely if ever attained by one so young.

Of M. Piazzi and his labours it will also be interesting to the Society to conceive a concise account, as this distinguished individual furnishes another example, in addition to the many already upon record, of the power of genius to deliver a man from pursuits for which he had no taste, and to carry him successfully through others, to promote which he was richly qualified. Piazzi was born at Ponte in the Valteline, July 16th, 1746, and died at Naples, July 22d, 1826. Early in life he was devoted to a religious order, denominated the *Théatins*, at Milan. But, after various changes, he, in 1780, accepted the appointment of Professor of the Higher

Mathematics in the Academy of Palermo; and from that time, entirely devoted himself to science.

In a few years he obtained the confidence and favour of the Prince of Caramanico, viceroy of Sicily, by whose permission and assistance he founded an observatory at Palermo. With a view to open an intercourse with astronomers, and to obtain valuable instruments for his observatory, he visited England, where he formed an intimacy with Maskelyne, Herschel, Vince, and Ramsden. From the last of these he obtained some very excellent instruments, and, amongst the rest, the Altitude and Azimuth instrument with which his principal observations were made. From this time Piazzi cherished a warm attachment both to the English and to their language; and to the latest period of his life, continued to evince the same esteem.

While he was in England, Piazzi observed at Greenwich, in conjunction with Maskelyne, the solar eclipse of June 3d, 1788. He also collected the corresponding observations of eighteen different astronomers in various parts of Europe, and deduced from them the differences in longitude of the several observatories from that of Greenwich. The results he published in the *Philosophical Transactions* for 1786 (vol. lxxix.); and the circumstance is here recorded, as this paper is understood to be M. Piazzi's earliest production as an astronomer.

In 1789 he commenced with great activity his labours in his new observatory, then the most southern which existed in Europe; that at Malta having been recently destroyed by fire.

On the 1st of January, 1801, he discovered the planet *Ceres*. The principal circumstances of that discovery, being well known to astronomers, need not be detailed here. But it is due to the character of this distinguished individual, to state, that when the king of Naples announced his intention of perpetuating the event, by the circulation of a gold medal among European observers, Piazzi, whose modesty and zeal were equal to his merit, requested the monarch to assign the proposed value of the medals to the purchase of an *equatorial*, which he thought was greatly needed in his observatory.

In 1803 he published the result of a labour of twelve years, undertaken with a view to determine *the mean position of the principal stars*; for this work he received the medal from the Royal Academy of Sciences at Paris.

In 1814 was published M. Piazzi's *New Catalogue*, from which it appeared that this indefatigable astronomer had actually extended his researches to 7646 stars!

Early in 1817 M. Piazzi published his *Lessons on Astronomy*, and the same year he was called to Naples, to put into activity the new observatory established on the heights of *Capo di Monte*. Cacciatore (now also one of the Associates of the Society,) has from that time taken the charge of the observatory at Palermo; and by his zeal and assiduity is emulating the conduct of his predecessor.

The subsequent labours of this indefatigable astronomer are as

universally known as they are highly appreciated throughout Europe. The grand work, however, to which we have already adverted (*The Catalogue of* 7646 *stars*,) will ever remain a monument of his superior activity and perseverance, as long as the science endures. This important work far exceeds every thing of the kind that has preceded it; and shews, more powerfully than words can express, what may be effected by the talents and assiduity of *one* individual.

The will of this eminent astronomer furnishes a new proof of his cordial desire to contribute perpetually to the promotion of his favourite science. He has bequeathed his library and all his instruments to the observatory at Palermo; and has assigned a liberal annuity to be devoted in succession to the instruction of young men who evince a marked partiality for this interesting department of knowledge.

The Council trust that the several members of this Society require no additional excitement to promote and advance the cause in which they have so laudably embarked. They should recollect, however, that without their cordial co-operation and assistance, the labours and efforts of the Council will be in vain. For the *Council* are merely the officers of the Society, and can only collect and arrange the subjects that present themselves. To the *individuals* of the Society it more properly belongs to furnish those subjects which may tend to the improvement of the science, either theoretically or practically. The Council have, indeed, in some of their former Reports, ventured to suggest several points as more particularly worthy of the attention of the members; but it must be obvious to every one, that these are a *few* only of the desiderata in astronomy; and that many others will suggest themselves to every skilful and intelligent observer.

The meeting then proceeded to the election of Officers for the ensuing year, when the following List was delivered in by the scrutineers: viz.

President: J. F. W. Herschel, Esq. M.A. *Sec.* R.S. *Lond.* F.R.S. *Ed.* & M.R.I.A.—*Vice-Presidents:* Capt. F. Beaufort, R.N. F.R.S.; Lieut.-Gen. Sir T. M. Brisbane, K.C.B. F.R.S. L. & E.; Henry Thomas Colebrooke, Esq. F.R.S. L. & E. F.L.S. & G.S.; James South, Esq. F.R.S. & L.S.—*Treasurer*: Rev. William Pearson, L.L.D. F.R.S.—*Secretaries:* Olinthus G. Gregory, LL.D. *Prof. Math. Roy. Mil. Acad. Wolwich;* Lieut. W. S. Stratford, R.N.—*Foreign Secretary:* Charles Babbage, Esq. M.A. F.R.S. L. & E. & M.R.I.A.—*Council:* Francis Baily, Esq. F.R.S. L.S. & G.S. & M.R.I.A.; Colonel Mark Beaufoy, F.R.S. & L.S.; Lieut.-Col. Thomas Colby, R.E. LL.D. & F.R.S. L. & E.; Capt. George Everest; Davies Gilbert, Esq. M.P. V.P.R.S. F.L.S. & G.S.; Benjamin Gompertz, Esq. F.R.S.; Stephen Groombridge, Esq. F.R.S.; James Horsburgh, Esq. F.R.S.; Hon. Lord Oxmantown; Edward Riddle, Esq.

J. Moyes, *Castle Street, Leicester Square.*

ASTRONOMICAL SOCIETY OF LONDON.

March 9, 1827. No. 2.

At this meeting there was read, a "Notice respecting some errors common to many tables of logarithms," by Charles Babbage, Esq., Foreign Secretary of this Society. Mr. Babbage having lately printed a stereotype table of the logarithms of the natural numbers, for the use of the Trigonometrical Survey in Ireland, for the sake of greater accuracy subjected them to eight readings and comparisons with other tables. This cautious process led to the detection of various errors, which are common to almost all the tables; those of Vega, the last impressions of Callet, and Mr. Babbage's own tables, being all that he has found free from the errors which he specifies. The tables subjected to this examination were those of Vlacq, Gouda, 1628, carried to ten figures; Vlacq, London, 1633; Wingate, London, 1633; Newton, in his *Trig. Britan.* 1658, to eight figures; Sherwin, London, 1726; 2nd ed. 1741; 3rd ed. 1742; Gardiner, London, 1742; Sherwin, 4th ed. 1761; 5th ed. 1770; Gardiner, Avignon, 1770; Schulze, Berlin, 1778; Gardiner, Furenze, 1782; Taylor, London, 1792; Vega, Leipsic, 1794; Callet, (stereotype,) Paris, 1795; Callet, ditto, Paris, (tirage,) 1825; Hobert and Ideler, Berlin, 1799; Delambre, Tab. Dec. Paris, 1801; Hutton, 4th ed. London, 1804; 5th ed. 1811; Vega, Leipsic, 1820; Hutton, 6th ed., London, 1822; Babbage, London, 1827.—Mr. Babbage thinks that the errors which he has detected can only be attributed to the universal system of copying which prevails in such works.

The numbers and *correct* logarithms to *seven* places are as below:

Numbers.	Logarithms.	Vlacq's last five figures.
24626	3913940	$39\bar{7}51$
38962	5906412	$1\bar{3}420$
57628	7606335	$35\bar{8}75$
57629	7606411	$10\bar{4}36$
63747	8044598	$97\bar{4}12$
67951	8321959	$58\bar{4}24$

From these the several tables specified may readily be corrected.

Mr. Babbage knowing that there was in the Library of the Royal Society a table of logarithms printed in the Chinese character, and which exhibits no indication or acknowledgment of its being copied from another work, was naturally desirous to compare it with European tables. On doing so, he found that in the *six* cases above noted, errors occurred precisely as in the European tables; thus furnishing an irresistible proof that the Chinese tables have an European origin.

There were next read two letters from Mr. Andrew Lang to F. Baily, Esq.: one dated St. Croix, 20th of March, 1826; the

other, St. Croix, 13th November, 1826. The first of these transmits an account of observations of the meridian transit of the moon's enlightened limb, and some stars preceding and following her, made at St. Croix, lat. 17° 44′ 32″ north, assumed long. 64° 45′ west, between September 22, 1825, and March 15, 1826. These were sent to Mr. Schumacher at the same time, and have been published in No. 104 of his *Astron. Nachrichten.*

Mr. Lang describes the climate of St. Croix as peculiarly favourable to astronomical observations, and speaks of the steadiness of the terrestrial refraction there. The terrestrial refraction scarcely ever varies perceptibly from the *one-sixteenth* part of the intercepted arc.

In Mr. Lang's second communication he presents a further account of the meridian transits of the moon's enlightened limb, and of moon-culminating stars, observed between March 30, and November 21, 1826. He also gives a summary of his observations of occultations of μ^1, and μ^2, *Sagittarii* by the moon, on the 9th of September; and of ψ *Virginis*, on the 28th of October.

Next, there was read a paper, "On a new application of the method of determining the time by observations of two stars when in the same vertical, to the case of *Polaris* when so situated with respect to any other circumpolar star in the course of its diurnal revolution below the pole: by Dr. T. L. Tiarks." The author first describes the peculiarities and advantages of this method, and then presents the investigation of the formulæ of computation. If l denote the co-latitude of the place of observation, d the polar distance of the pole-star, D that of the other star, α their difference of right ascensions, and t the time elapsed from the upper passage of the pole-star to the moment of its being on the same vertical with the other; then the result of the investigation gives

$$\text{(I)} \ldots\ldots \sin(t + \varphi) = \frac{\sin \alpha}{\gamma \tan l}.$$

The values of γ and φ being determined by the following equations: viz.

$$\text{(II)} \ldots\ldots\ldots \gamma = \frac{(\sin D - d)}{\sin d \sin D \cos \psi}.$$

$$\text{(III)} \ldots\ldots \tan \psi = \frac{\sin \frac{1}{2}\alpha \surd(\sin 2 D \sin 2 d)}{\sin (D - d)}.$$

$$\text{(IV)} \ldots\ldots \sin \varphi = \frac{\sin \alpha}{\gamma \tan d}.$$

The author occupies a portion of his paper in tracing the limits of error, and in pointing out in what cases the method is not strictly true.

Lastly: There was read a letter from M. Gambart to the President, dated Marseilles, 30th of December, 1826. After adverting to what may be supposed his temerity in anticipating the transit of the comet seen in Boötes over the sun's disc, on the 18th of November, he presents the elements of the parabolic orbit of another comet, which are as below: viz.

Passage of the perihelion 1827.	$34^d{\cdot}989$ M.T. from midn^t.
Perihelion distance	0·455
Longitude of perihelion	34° 0′ 50″
Longitude of the node	191 44 33
Inclination	72 4 15

Motion retrograde.

M. Gambart exhibits a comparison of the results of these elements, and of his observations on the 27th, 28th, and 29th of December.

The President read part of a private letter from M. Littrow, Director of the Imperial Observatory at Vienna, stating that his Majesty the Emperor of Austria has liberally authorised the purchase, for that observatory, of a refractor, similar in all respects to that made by Fraunhofer for the Observatory at Dorpat, and which, at the death of that excellent artist, was left (so he understood the words "*des noch übrigen*") by him amongst his other instruments undisposed of.

J. Moyes, Castle Street, Leicester Square.

ASTRONOMICAL SOCIETY OF LONDON,

April 11, 1827. No. 3.

A PAPER by Colonel Beaufoy was read, containing his Observations of Eclipses of Jupiter's Satellites, from January 2 to May 15, 1826, together with some Observations of occultations of stars by the moon.

A paper was also read "On the Longitude of Madras, as deduced from Observations of Eclipses of the first and second Satellites of Jupiter, taken between the years 1817 and 1826. By John Goldingham, Esq. F.R.S."

The eclipses stated in this paper are 96 in number, being Immersions and Emersions of the 1st and 2d Satellites only. Of these, 11 are directly comparable with those of Colonel Beaufoy, made at Bushy Heath, viz. 8 of the 1st, and 3 of the 2d; and their mean result, which of course is independent of the errors of the tables, is stated by Mr. Goldingham at $5^h\ 21^m\ 9^s{\cdot}3$, being the longitude of Madras east of Greenwich. The remainder, consisting of 34 Emersions and 35 Immersions of the 1st Satellite, and 12 Emersions and 4 Immersons of the second, are not directly comparable with Colonel Beaufoy's. Mr. Goldingham endeavours, however, to render them so, or at least to eliminate the errors of the tables, by determining the latter from Colonel Beaufoy's observations made nearly about the same time, and then applying it to the results of a comparison of his own with the Nautical Almanac as a correction; and in this way deduces a conclusion agreeing almost exactly with the foregoing.

This is not the place to enter into any discussion on the legitimacy of the process pursued by Mr. Goldingham for this purpose, or of its general applicability in the present state of the tables. The end of this abstract will be better answered by presenting in one view the results of these several classes of observations as obtained separately, by direct comparison with the Nautical Almanac, *uncorrected* by reference to Colonel Beaufoy's, or any other observations, which may be stated as follows:

Madras East of Greenwich.

By 34 Emersions of the 1st Satellite observed at Madras, and compared with the Nautical Almanac	5^h	21^m	$6^s{\cdot}5$
By 35 Immersions of ditto, similarly observed and compared	5	21	12·4
Mean longitude of Madras	5	21	9·4
Difference of Immersions and Emersions			5·9

By 12 Emersions of the 2d Satellite, similarly observed and compared	5^h	21^m	$0^s{\cdot}5$
By 4 Immersions of ditto	5	21	33·1
Mean longitude.....	5	21	16·8
Difference of Immersions and Emersions....			32·6

The latter series has, however, only the weight of four double observations, and is therefore no way to be put in competition with the former, corroborated as it is to minute precision by the results of the comparative observations; so that on the whole we may take $5^h\ 21^m\ 9^s{\cdot}35$ as the true longitude of the Madras observatory.

Mr. Goldingham states the difference of longitudes between the Observatory and Fort St. George at 2′ 21″ (of space), the latter being to the east; so that the longitude of Fort St. George, Madras, is $5^h\ 21^m\ 18^s{\cdot}7$.

Immediately after the conclusion of the ordinary meeting of the Society, a *Special General Meeting* was held, pursuant to a notice to that effect, for the purpose of distributing the Honorary Medals awarded by the Council; on which occasion the President read the following address.

GENTLEMEN,

The ordinary business of the evening being now terminated, it remains to fulfil the object for which we are especially convened this night, which is one of no less interest than the distribution of the Honorary Medals awarded by your Council, in pursuance of the principle of encouraging works of great labour, and high practical utility, steady perseverance in astronomical observation, and in redemption of the pledges held out in the address circulated at the origin of this Society, explanatory of its objects.

On former similar occasions when we have been called on to witness the execution of this important duty, it has frequently been our good fortune to acknowledge and applaud the claims of foreign merit, and to prove by our awards, that no mean jealousies, or narrow and mistaken views of national honour, are capable of blinding our judgment or biasing our decision; but that he who, whatever be the spot of earth he inhabits, most promotes the cause of astronomical science, is most our brother and our countryman. Yet, I am sure it will be gratifying to you to know that on this occasion ample scope has been found for selection in the merits of our own compatriots, and in the home list of our members. It is not that great and important astronomical works have not emanated from our continental neighbours: on the contrary, the spirit of research and discovery appears to have prevailed with extraordinary activity; and the last year has even witnessed the addition to our system of another of those singular bodies, the discovery of which has conferred so much lustre on the names of Halley and Encke. No less than three independent claimants to the almost simultaneous disclosure of this interesting fact may be enumerated; and this circumstance, while it marks the spirit of the age more forcibly perhaps than any *trait which could* be produced, must obviously render it impossible

for this Society to interfere or decide on the priority and rank of the competitors. But though unmarked by any tangible memorial of our approbation, the names of Biela, Clausen, and Gambart, will not the less be cherished among us, and enrolled by posterity in the choicest and most permanent annals of Astronomical celebrity.

It is, however, for labours of a very different kind that our medals are this day to be conferred. Labours, if less brilliant, yet more vital; if less associated with lofty speculations on the nature of the universe, yet more intimately linked with the practical uses of this world. The first award of your Council is that of a gold and silver medal, respectively, to your late excellent President Mr. Baily, and your indefatigable Secretary Mr. Stratford, for their joint labours in the construction of the Catalogue of 2881 principal fixed stars, which forms the Appendix to the second volume of the Memoirs of this Society.

A catalogue of stars may be considered in two very distinct lights, either as a mere list of objects placed on record, to fix on them the attention of astronomers, and to afford them matter for observation, or as a collection of well-determined zero points, offering ready means of comparing their observations with those of others, and of detecting and allowing for instrumental errors. In this light only I shall now consider it as chiefly of importance to the practical astronomer. It is for his uses that an amount of pains, labour, and expense, both national and individual, has been bestowed on the perfection of such catalogues, which, on a superficial view, must appear in the last degree lavish, but which yet has been no more than the necessity of the case demands. If we ask to what end magnificent establishments are maintained by states and sovereigns, furnished with master-pieces of art, and placed under the direction of men of first-rate talent and high-minded enthusiasm, sought out for those qualities among the foremost in the ranks of science:—if we demand *cui bono?* for what good a Bradley has toiled, or a Maskelyne or a Piazzi worn out his venerable age in watching? the answer is,—not to settle mere speculative points in the doctrine of the universe; not to cater for the pride of man, by refined inquiries into the remoter mysteries of nature,—to trace the path of our system through infinite space, or its history through past and future eternities. These indeed are noble ends, and which I am far from any thought of depreciating; the mind swells in their contemplation, and attains in their pursuit an expansion and a hardihood which fit it for the boldest enterprise.—But the direct practical utility of such labours is fully worthy of their speculative grandeur. The stars are the land-marks of the universe; and amidst the endless and complicated fluctuations of our system, seem placed by its Creator as guides and records, not merely to elevate our minds by the contemplation of what is vast, but to teach us to direct our actions by reference to what is immutable in his works. It is indeed hardly possible to over-appreciate their value in this point of view. Every well-determined star, from the moment its place is registered, becomes to the astronomer, the geographer, the navigator, the surveyor,—a point of departure which *can never* deceive or fail him,—the same for ever

and in all places, of a delicacy so extreme as to be a test for every instrument yet invented by man, yet equally adapted for the most ordinary purposes; as available for regulating a town clock, as for conducting a navy to the Indies; as effective for mapping down the intricacies of a petty barony, as for adjusting the boundaries of transatlantic empires. When once its place has been thoroughly ascertained and carefully recorded, the brazen circle with which that useful work was done may moulder, the marble pillar totter on its base, and the astronomer himself survive only in the gratitude of his posterity: but the record remains, and transfuses all its own exactness into every determination which takes it for a groundwork, giving to inferior instruments, nay even to temporary contrivances, and to the observations of a few weeks or days, all the precision attained originally at the cost of so much time, labour, and expense.

To avail ourselves of these records, however, we must first have the means of disentangling the observed places of the stars at any moment, from the regularly progressive effect of precession, and from a variety of minuter periodical inequalities arising from the nutation of the earth's axis, and from the aberration of light, of which the genius of theoretical, no less than the industry of practical, astronomers has at length succeeded in developing the laws, and fixing the amount, so as to leave little probability of any material change being induced by future researches.

The calculations, however, required for this purpose, if instituted for each particular star at the time it is wanted, are so numerous and troublesome as to become a very serious evil; the effects of which have been severely felt in Astronomy in the discouragement it has offered to the reduction of observations, owing to which the labour of many an industrious observer's life has been in great measure thrown away. Indeed a lamentable picture might be drawn of the waste of valuable labour traceable to this cause. The want of tables, therefore, to facilitate the reduction of particular stars was early felt. I shall not, however, enter into any historical detail of the attempts hitherto made from time to time to supply this desideratum. A well-drawn up and concise account of them is given in Mr. Baily's Preface to the Catalogue, which renders superfluous all I could say on the subject. Indeed, useful as they have been, and considerable as has been the pains bestowed on them, they are all so far surpassed by this work of Mr. Baily, that it ought rather to be considered as belonging to a new class, than to be compared in any way with the preceding ones, which must eventually all be superseded by it.*

It is time now to speak more particularly of the Catalogue itself. Its whole plan and arrangement, the selection of the stars, the preparation and revision of the formulæ, the choice of the coefficients,

* From this sentence, however, I ought to except special tables for the daily reduction of a certain number of select stars, whose use is no way superseded by the general Catalogue, being destined for continual, as the latter is only for *occasional, reference.*

and the discussion of the terms to be retained or rejected, we owe to Mr. Baily, who has stated every particular relating to it in a most elaborate Preface, which may indeed be regarded as a compendium of all that is known on the subject of the corrections, and is remarkable at once for its precision and perspicuity. A great portion of the computation has been gratuitously performed by Mr. Stratford, checked by a computer engaged for that purpose. From this very severe labour, however, he was unfortunately compelled to desist, I regret to say, by ill health, and his place supplied by a professional computer: but the hardly less laborious task of comparing and checking the computations of his assistants, and, what is as important in all such cases as accuracy of computation, the careful superintendence of the press, and repeated revision of the whole work, has entirely devolved on him; and never, I must say, was task performed with more diligence and exactness.

The selection of the stars has been made from the Catalogues of Flamstead, Bradley, Lacaille, Mayer, Piazzi, and Zach, so as to include all stars down to the 5th magnitude, wheresoever situated in the heavens,—all of the 6th within 30° of the equator, and all the stars to the 7th magnitude inclusive, within 10° of the ecliptic. Almost all of them, however, are to be found in the Catalogues of Bradley or Piazzi, from which they have been reduced to 1830, (the epoch adopted) by formulæ given by Bessel. Their number is so considerable, that in whatever part of the heavens we may be observing, one or more are sure to be within a moderate distance; so that no one provided with this Catalogue can possibly be at a loss for a zero-point to check his observations, and ascertain the state of adjustment of his instrument. To its convenience and utility, in this respect, I can speak from individual experience. It is indeed become my sheêt anchor, and has infused into a series of observations wholly dependent on such aid, a degree of exactness which, without it, I should hardly have expected to attain.

The formulæ employed for calculating the corrections are almost entirely those of Bessel, who has laboured with such diligence and perseverance on this department of Astronomy, as to make the subject almost his own. In adopting them, however, Mr. Baily has taken nothing for granted, even from such high authority. He has gone over the whole subject anew; and the slight inaccuracies which he has detected and corrected in several of the results of this profound geometer, although almost insensible in a numerical point of view, are valuable, as proving at once the general accuracy of his investigations, and the minuteness of the scrutiny they have undergone.

The most delicâte part of the whole operation, however, was the choice of the several coefficients, which, if erroneously assumed, would render the whole subsequent work of no value. In making this assumption, Mr. Baily has exercised a degree of judgment which I feel convinced will unite the suffrages of astronomers. Taking a comprehensive view of the results afforded by all former investigations, he has uniformly adhered to the principle, to steer

clear of extreme quantities, and to adopt only such as not only rest on the greatest number of the best observations, but agree in their values nearly with the average of all. Thus, in the case of the aberration, the value adopted is the mean of the almost miraculously coincident results of Brinkley and Struve, and agrees within two-hundredths of a second with that of the extreme values assigned by Bradley and Bessel. I have much satisfaction in being enabled to state, that this value has been recently confirmed within a very minute fraction of a second, by the praiseworthy zeal and industry of Mr. Richardson of the Royal Observatory, who has compared, for this purpose, upwards of 2000 observations, made with the two mural circles of Jones and Troughton; so that this datum may be regarded as one of the best established in Astronomy. In the same cautious manner has Mr. Baily proceeded with the other coefficients. That of precession he has taken entirely from Bessel's elaborate investigations compared with those of Laplace, in which the only remaining source of uncertainty is that arising from our ignorance of the mass of Venus; the influence of which cannot possibly produce an error, however, of a tenth of a second in the precession. The nutation he has taken, as it results from Dr. Brinkley's observations, which (like his aberration) justify this partiality by holding almost exactly an average value among all the different results of Bradley, Mayer, Maskelyne, Laplace, and Lindinau, and can hardly be considered as more than a tenth of a second in error.

This judicious choice will secure the present tables from a possibility of ever sharing the fate of preceding labours of this sort. They can never be superseded by others of greater accuracy, nor fall into disuse, or grow obsolete, till the apparent places of the stars shall have become so much altered by the effect of precession as to render the computations inexact, for which a very long series of years will be required.

But the distinguishing characteristic of this work is the adoption throughout of Professor Bessel's capital improvement in the system of applying the corrections, by arranging the formulæ in such a manner that all that is peculiar to each star, and permanent in magnitude, shall stand distinctly separated from all that is ephemeral, or varying from day to day; and that in such a manner that a short ephemeral table, capable of being compressed into a single page, shall serve, not only for these stars, but for every star in the heavens. The convenience of this method, the brevity it introduces into the computations, the distinctness it gives to all the process of reduction, requiring neither thought nor memory on the computer's part, give it an incalculable advantage over every other. To reduce any observation, no other book need be opened. The work occupies four lines, and is done in half that number of minutes. If we compare this with the tedious and puzzling operation required by former processes, we shall fully agree with Mr. Baily, that "those only who are versed in such calculations can appreciate the labour, the risk of error, and the loss of time incurred in their several operations;" all which are saved by the present arrangement.

These considerations will amply justify the award of your Council in your eyes and those of the world. They will justify a great deal more. At no time was the necessity of pressing on the attention of astronomers the utility, I may say, the duty, of uniformity in their systems of reduction more urgent than at present,* when hardly a nation in Europe is unprovided with a good observatory, and when rival astronomers in all quarters of the globe are contending for the palm of accuracy and diligence. So long as they persist in continuing to reduce their observations by different systems, their merits can never be fairly compared. Each may boast the perfection of his instruments, and vaunt himself in the security of his pre-eminence. Each may promulgate his standard Catalogue, which will be adhered to in his own nation, and rejected by all others; thus dividing astronomers into sects and parties,—a state of things which ought surely not to continue. The only remedy is to agree to speak one language, to adopt one system. It matters little in the present advanced state of science, whether that system be still open to infinitesimal corrections. Let astronomers only consent to use it as, like all human works, confessedly imperfect, and in process of time to be corrected: but not at the caprice of each individual who may think one coefficient a tenth of a second too small, or another as much too great; but after full consideration, when the necessity and amount of correction shall have become certainly known and generally agreed on.

Meanwhile, a fair opportunity is offered to rival astronomers throughout the world, to try their strength, in an arena of ample extent, and where every part of the honourable contest will be brought distinctly into sight. In giving this Catalogue to the world, we invite their examination to its errors, (for such it must contain), and call on them to lend their aid to its perfection, by determining, with all the exactness their resources afford, the mean places of the stars it comprises. For this, its arrangement affords every facility, and those who observe, have no excuse for neglecting to reduce. Let us hope then, that instead of lavishing their strength in fruitless attempts to give superhuman precision to fifty or a hundred select objects, the formation of a standard Catalogue of nearly 3,000 will be deemed of sufficient importance to fix the attention of astronomers; and that not only those to whom the direction of great national observatories is confided, but even private individuals, if such there be, who feel themselves in possession of the means required, may take a share in this glorious, but at the same time arduous undertaking.

(*The President then, delivering the Gold Medal to Mr. Baily, addressed him as follows:*—)

Mr. Baily,

Accept this Medal, which the Astronomical Society bestows on you, by an award which every astronomer in Europe will confirm.

* This applies with equal or greater force to the correction for refraction; a common table for which ought to be agreed on and adhered to by all.

The work you have accomplished will identify you with the future progress of that science, into almost every department of which it is calculated to infuse new life; since every practical astronomer has in it to thank you for an accession of power. It is needless for me to accompany this testimony of the sense the Society entertains of your distinguished merits, with the expression of a hope that your exertions in the cause of Astronomy will continue. You could not struggle against nature so far as to desist from pursuits which, demanding of ordinary men a total devotion of their time, and concentration of their whole intellectual powers, have been to you a relaxation from the most active business. Possessing thus within yourself a source of pure and exalted enjoyment, enhanced by the consciousness of public utility, and a certainty of the approval and admiration of those whom you esteem, we can only add our wishes that length of years, and continuance of health, may render your distinguished talents, and rare zeal for the promotion of your favourite science, as useful to Astronomy as it is honourable to yourself.

(*The President next presented the Silver Medal to Mr. Stratford, addressing him at the same time in these words:—*)

MR. STRATFORD,

The Medal which, in the name of the Astronomical Society, I now deliver to you, though "less fine in carat" will, I trust, be to you "more precious" than gold, as proving how highly we appreciate your devoted and persevering attention to the work you have so happily brought to a conclusion. Those only who have actually entered into the details of a work of this nature can possibly understand the overwhelming and soul-sickening labour of such a task; but the pile of volumes now lying on the table, a great portion of which you have yourself penned, and the whole of which you must in the course of your undertaking have repeatedly read over, figure by figure, will serve to give some idea of it. In executing this arduous duty, you have had no other inducement than your zeal for the progress of science, and that devotion to the interest of this Society which is so conspicuous in every part of your conduct, and which would not suffer you to tolerate the idea of any incorrectness, any thing unworthy the importance of the subject emanating from it. The habits of correctness in numerical computation, and systematic fidelity of detail indispensable for such a work, you possess, though in perfection, yet in common with many: but the enthusiasm in the cause of abstract science, which could carry you successfully through the task thus voluntarily imposed on yourself, you share with few. You have, however, the satisfaction of knowing that so much labour has not been bestowed in vain; for, if there be any thing on which we can calculate with certainty, it is that the work you have been mainly instrumental in completing, must exereise a powerful influence on the future destinies of Astronomy.

(*The President then resumed his Address to the Members in general, as follows:—*)

GENTLEMEN,

We have still another, and a very interesting part of the business of this meeting to perform, in the delivery, to Colonel Beaufoy, of a Medal for his valuable series of observations of eclipses of Jupiter's satellites, communicated to this Society, and in part already printed in the first part of the second volume of our Memoirs; in part recently read at a late meeting, and completed up to the present time, by the paper you have heard read to-night.

The subject of the eclipses of Jupiter's satellites is one of singular interest in the history of Astronomy. The discovery of these bodies was one of the first brilliant results of the invention of the telescope; one of the first great facts which opened the eyes of mankind to the system of the universe — which taught them the comparative insignificance of their own planet, and the superior vastness and nicer mechanism of those other bodies, which had before been distinguished from the stars only by their motion, and wherein none but the boldest thinkers had ventured to suspect a community of nature with our own globe. This discovery gave the holding turn to the opinions of mankind respecting the Copernican system: the analogy presented by these little bodies (little, however, only in comparison with the great central body about which they revolve) performing their beautiful revolutions in perfect harmony and order about it, being too strong to be resisted. As if to confirm this analogy beyond dispute, Kepler lived just long enough to witness the discovery, and to demonstrate* the extension of the same general law to their periods which he had found to obtain among those of the primary planets about the sun. The conclusion was irresistible; and the full establishment of the Copernican System must date from the discovery of the satellites of Jupiter.

This elegant system was watched with all the curiosity and interest the subject naturally inspired; and the eclipses of the satellites speedily attracted attention, and the more when it was discerned, as it speedily was, by Galileo himself, that they afforded a ready method of determining the difference of longitudes of distant places on the earth's surface by observations of the instants of their disappearances and reappearances simultaneously made. Thus, the first astronomical solution of the great problem of the longitude,—the first mighty step which pointed out a connexion between speculative astronomy and practical utility, and which, replacing the fast-dissipating dreams of astrology by nobler visions, shewed how the stars might really and without fiction be called arbiters of the destinies of empires,—we owe to the satellites of Jupiter; to those atoms, imperceptible to the naked eye, and floating like motes in the beam of their primary—itself an atom to our sight—noticed only by the careless vulgar as a large star, and by the philosophers of former ages as something moving among the stars—they knew not what—nor why; perhaps only to perplex the wise with fruitless conjectures, and harass the weak with fears as idle as *their* theories.

* According to Delambre, this extension of Kepler's law is due to Vendelinus.

No wonder now that the eclipses of the satellites were watched with anxious, earnest interest; they were soon to afford matter for yet greater wonder and deeper contemplation. Roemer's discovery of the velocity of light from the retardation of their eclipses about the end of the 17th century, was the next in order, and the sublimest truth they were destined to be the means of unfolding; a truth so amazing, so overwhelming to human faculties, that (not to mention the feebler names of Cassini, Maraldi, and Fontenelle) even the comprehensive genius of a Hooke quailed before it, and refused to admit the existence of a motion so little short of infinite in a finite system like our own. The discovery of the aberration of light by Bradley, however, more than forty years afterwards, confirmed it in its full extent; and no truth in the circle of physical science is either more astonishing, or better established than this.

We are not yet come to the end of the long catalogue of useful and admirable results afforded to science and to mankind by the discovery of these bodies. We have hitherto regarded only obvious results; broad and evident conclusions from apparent facts. Let us now trace them in the quiet succession of their convolutions, in the unfolding of their periodical inequalities, in the slowly accumulating amount of their mutual action, in the influence of the oblate figure of their primary on their orbits; in short, through all the mazy intricacies of their perturbations. The lessons they have thus whispered to the intellect of man, over the midnight lamp, have not been less instructive, less fraught with wonder and utility, than those which they have blazoned to his senses. It is to that powerful and gifted genius, now so recently gathered in an illustrious grave; on whose ashes the tears of mourning science are yet warm,—to him, whose revered name, so freshly sanctified by death, I am unwilling to pronounce, that we owe the complete development of their theory. His penetrating mind saw all the advantages likely to accrue to the general theory of the planetary perturbations from the study of this miniature system, where years are represented by days, and ages by years, and where inequalities, which in the planetary theory have a character approaching to secular, can be traced in their increase and on their wane. Aided, therefore, by his powerful analysis, he succeeded in applying the law of gravitation to the minute investigation of all their inequalities; and the result has been not merely another triumph of the Newtonian theory in the complete explanation of all their complicated irregularities, but the formation of tables even more perfect than observation itself:* and in addition, a mass of most valuable and instructive information on the general nature of planetary perturbations, amply repaying all the labour of the inquiry, and adding fresh lustre to the already imperishable glory of his name.

This slight sketch of the history of the satellites of Jupiter may serve to shew how intimate is the connexion of distant parts of science with each other, and that in it we are to regard nothing as

* *Than* any single observation.—*Delambre.*

trivial, and nothing as great in itself, but in respect of the instruction we may draw from it;—to shew, in fine, how deep are the foundations and how wide-spread the ramifications of that tree of knowledge which, in the poet's words,

> ..... quantum caput ardua ad astra
> Attollit—tantum radice in Tartara tendit.

which draws its increments from small beginnings and matters of speculative curiosity, and ends in becoming the ornament, the shelter, and support of society.

It is by observations of the eclipses of the satellites alone that their theory can be compared with nature, their apparent distances from the planet being too small, and its change too slow, to admit of micrometrical measurements precise enough for the purpose, though perhaps the modern improvements both in the telescope and micrometer may authorise a hope that this may not long be an insuperable difficulty. Accordingly, from the time of Roemer downwards, a series of eminent astronomers have occupied themselves with observations of these phenomena; and it is on no less than two thousand of such observations that Delambre, improving on the tables of Wargentin by the aid of the profound theory just alluded to, succeeded in calculating the first series of tables laying claim to precision.

The longitude is so much better ascertained now by lunar distances and occultations, that these observations are less resorted to than heretofore for that purpose. Nevertheless, they are occasionally used, especially those of the first and second, whose eclipses not only happen much more frequently, but are much more definite, than those of the exterior ones. Indeed, the observations of the latter have been declared by high authority, utterly useless. It is not always good, however, to trust to authority; and Mr. South, by a comparison of his own with Colonel Beaufoy's observations, has arrived at a very different conclusion, at least for the cases when both the beginning and end of the eclipse can be seen. Still, however, it is highly desirable that they should continue to be assiduously observed, not merely to furnish corresponding observations, but to afford the means of further perfecting the tables, so as ultimately to enable us to dispense with corresponding observations altogether.

Colonel Beaufoy has for many years past been a most careful and assiduous observer of these eclipses, and indeed of all occasional phenomena; such as occultations, eclipses both solar and lunar, and of late of that very useful and important class, the transits of moon-culminating stars, of which one of his recent communications contains an extensive and highly interesting series. His observations of the immersions and emersions of the satellites communicated to this Society, amount to no less than 180, all (with the exception of two or three of the earlier ones) being made in the interval from 1818 to 1826 inclusive;—a fine series, indeed a surprising one, when the comparative rarity of the phenomena is considered, not *more than* about 40 visible at Greenwich occurring

annually on an average; and when the great drawback on observations of this sort from unfavourable weather in this anti-astronomical climate is taken into the account. What chiefly adds to their value as a series, however, is the circumstance of their being all made by one observer, and with one telescope,—a fine five-feet achromatic of Dollond, and with the same magnifying power, 86. In no class of astronomical observations is uniformity in this respect of such importance, since the variations in the times of appearance and disappearance, when observed at the same spot, simultaneously, by different observers with different telescopes, is found to amount not merely to a few seconds but to whole minutes.

It must be a matter of deep regret to us all, both for his own sake and for that of astronomy, that so valuable and interesting a series of observations should sustain, what I trust, however, will prove only a temporary interruption from the severe illness of Colonel Beaufoy, which alone prevents him from receiving in person the mark of our approbation adjudged him by your Council. At his request, therefore, I will hand it to our worthy Secretary.

(*Here the President delivered the medal to Mr. Stratford, as proxy for Colonel Beaufoy, at the same time thus addressing him:*—)

MR. STRATFORD,

When you shall transmit this medal to Colonel Beaufoy, accompany it with the assurance of our warmest approbation of the useful and excellent example he has set, in thus steadily prosecuting from year to year, a train of observations so important in itself, and requiring so much patient and persevering attention: an example we trust to see emulated by others; since it shews how much, how very much, may be done with moderate instrumental means, by regular, systematic, and well-directed observation. He has succeeded in rendering his name conspicuous among astronomers, and his observatory a standard point of reference,—one of those zero points on earth which, like the standard stars in the heavens, will serve for the determination of innumerable others. Already we are furnished with a conspicuous instance of its use in this respect, in the determination of the longitude of Madras by Mr. Goldingham, which has this night been read to the Society, in which that important element is derived from a very moderate number of corresponding observations made at the two stations, with considerable presumption of exactness. Nor can we suppose that this will prove a solitary instance. Assure Colonel Beaufoy how much we consider science as practically benefited by his labours:—assure him too of our lively grief and sympathy for his present sufferings, and our earnest wishes and prayers that he may be speedily restored to the full enjoyment of health, to his friends, and to his favourite Astronomy.

J. Moyes, Castle Street, Leicester Square.

ASTRONOMICAL SOCIETY OF LONDON.

May 11, 1827. No. 4.

THERE was read a paper "On the approximate places and descriptions of 295 new double and triple stars, discovered in the course of a series of observations with a 20-feet reflecting telescope; together with some observations of double stars previously known." By the President. The author prefixes a few remarks to this catalogue of stars, in which he first explains why the places of the stars which it contains are probably materially more exact than those of his former catalogue, especially in right ascension. He then records some results of his observations, either in themselves considered, or in comparison of preceding observations of Mr. South, and some other astronomers. Thus, the curious double star, $\mathcal{R}$ 17^h 52^m $1^s,5$, so remarkably situated in the midst of a very large and conspicuous nebula, affords a striking instance how easily the latter class of objects may be overlooked in the usual mode of conducting astronomical observations. Mr. South measured this star in the 5-feet equatorial, but the nebula, which forms so interesting an appendage to it, entirely escaped his notice. The observations of ξ *Ursæ Majoris* supply a satisfactory confirmation of its motion, in conjunction with those of Mr. South in the spring of 1825, its angular motion being found to be about 7° per annum. Since Mr. Herschel's first observation of this star, in conjunction with Mr. South in 1823, it has described nearly a twelfth of its revolution. This star, therefore, is earnestly recommended to astronomers, as frequent and careful observations upon it can scarcely fail to develope the law of gravitation in that remote system. Both the stars in α *Capricorni* are double: and that usually designated as α^2, Mr. H. characterises as one of the most beautiful and delicate objects in the heavens. The introductory remarks terminate with an account of a curious meteorological phenomenon, which occurred on the 19th of April last. The paper concludes with a catalogue of new double stars, arranged in the manner of the author's former catalogue.

There was next read a paper from Mr. Curnin, the Superintendent of the Observatory at Bombay, communicating a regular series of observations of moon-culminating stars, on the several previously arranged days, for the lunations in the months of February, March, April, May, and a few detached observations on similar stars in August and September, in the year 1825. These observations were made with a transit instrument of only two feet focal length, and little more than two inches aperture, placed in a temporary observatory. The deviation of this instrument from the meridian, in the

early part of the observations, was nearly one minute in time; but it is not mentioned whether the deviation was easterly or westerly: and Mr. Curnin remarks, that the error of its position on each day is stated "till the smallness of the deduced deviation and the opposite direction of it, were thought to be the effect of the errors of observation; and within narrower limits I have not yet attempted to bring the instrument, as I have not a catalogue on which I could rely for the mean place of stars that are well adapted for the purpose, nor a time-piece of sufficient regularity to justify my dependence on it, nor a meridian mark to guide me in the execution of it." It cannot be expected, therefore, that observations made under such unfavourable circumstances can throw much light on the practical solution of that difficult problem, the determination of the longitude, where the greatest accuracy is necessary. It is understood, however, that a new set of instruments has lately been forwarded to the Observatory at Bombay, at the expense of the East India Company; and the public therefore may soon expect to reap the benefit of so laudable an exertion of patronage and public spirit.

This was followed by the reading of a paper by Professor Littrow, director of the Imperial Observatory at Vienna, "On the determination of azimuths by observations of the pole-star." The principal object of this communication is to shew that the observations of the pole-star, not merely at the times of its greatest elongation, but at any points in its dirunal revolution, may be advantageously employed in the determination of azimuths. After Mr. Littrow has explained his process of observation, he investigates the theorems requisite in the computation. Let t be the mean of the times of observation, T the corresponding sidereal time, the horary angle of the pole-star $s = \mathrm{T} -$ apparent A, p be the apparent polar distance, φ the elevation of the pole, A the arithmetical mean of the azimuths of the star read off the instrument, while O is the mean of the corresponding azimuths of the terrestrial object chosen. Then the theorem for the azimuth ω of the star, at the time of the middle of the observations, is

$$\omega = \frac{p \sin s}{\cos \varphi} + \partial \omega + \mathrm{M}\, \partial^2 \omega$$

and the azimuth of the terrestrial object is $\alpha = \omega \pm (\mathrm{A} - \mathrm{O})$.

The determination of the values of $\partial \omega$ and $\partial^2 \omega$, which depend partly upon series, is explained in the paper, as well as the mode of determining them by a small subsidiary table, easily computed. The application of the method is then shewn by some examples from observations in July last year, in which two distinct results of observations with the face of the circle towards the east and towards the west, agree within half a second.

A communication from G. Dollond, Esq. was then read, giving an account of a singular appearance observed during the solar eclipse on the 29th of November last. The morning was cloudy, but soon after the commencement of the eclipse there was a partial opening in the clouds, through which Mr. D. saw *a considerable*

part of the limb of the moon which had not yet entered on the disc of the sun. Continuing his observations, after a short time, as the clouds passed on, he again saw both the sun and a portion of the moon's border *which was off the sun's disc.* The sky then became cloudless, and he could no longer discern any part of the moon's limb, except that which eclipsed the sun. This unexpected occurrence Mr. D. thinks may be turned to advantage, as it seems to shew that the reduction of the sun's light, by the intervention of an opaque substance, may enable an observer to see the moon when she is very near the sun.

There was next read, A letter from Mr. Reeves of Canton, giving an account of a comet seen at sea, Oct. 3d, 4th, 5th, 10th, and 30th, 1825. When it was first observed, the ship was in lat. 7° 20′ N. long. 110° 20′ E., the comet was in a line between η *Eridani* and π *Ceti*, about one-third of the distance from the former star. It then passed π *Ceti*, advanced toward σ *Ceti;* and at length, on the 30th of October, was seen so near to α in the western wing of the Crane, that that star appeared to form the nucleus of the comet. Shortly afterwards the comet entirely disappeared.

Lastly; A letter was read from M. Gambart to the President, containing new elements of the comet which passed across the sun's disc in Nov. 1826, with a more precise determination of the moment of its leaving the disc; from which he concludes that both himself and M. Flaugergues of Viviers must have observed the sun before the comet left it. As, however, neither of them saw the comet, the conclusion drawn is, that it was too small or too rare to be visible in that situation.

J. Moyes, Castle Street, Leicester Square.

ASTRONOMICAL SOCIETY OF LONDON.

June 8, 1827. No. 5.

THERE was read a paper by F. Baily, Esq. entitled "Remarks on the Astronomical Observations of Flamsteed." The object of this communication is to draw the attention of astronomers to the observations of that eminent observer, which the author considers, from their great number, from the care bestowed upon them, and from the very long period elapsed since they were made (nearly 140 years), to be deserving of more strict examination than they appear yet to have received. The imperfection of the instruments used by Flamsteed appears to have been one chief cause of this neglect, being in fact only a mural arc of 120°, with cross wires in the focus of the telescope fixed in the plane of the meridian, and an uncompensated clock. The arc, though of 80 inches radius, could be read off only to 10″, or at most, by an estimation of proportional parts, to 5″. With these, however, imperfect as they necessarily were, he succeeded in constructing a catalogue of the mean right ascensions and declinations of about 3000 stars, which has served as a basis for the observations of all subsequent astronomers.

This catalogue was of course very inadequately reduced. Aberration and nutation were unknown in Flamsteed's time, and refraction very imperfectly; so that the catalogue, as it stands, cannot be considered as at all fairly representing the observations. It was, however, for many years the only catalogue in the hands of astronomers, till it gave way to Mayer's, which being deduced from observations made with better instruments, and by an astronomer of great ability, was held more worthy of confidence. But, Mr. Baily observes, the observations of Mayer were made in precisely the same way as Flamsteed's, the right ascensions being determined by the time of the star's passing the vertical wire of the telescope of a mural quadrant. His clock, however, was compensated, and his arc better divided, and no doubt better adjusted. More confidence therefore is to be placed in any *one* observation of Mayer's than in any corresponding *one* of Flamsteed's. But the number of Mayer's stars is not above one-third of Flamsteed's; the greater part were observed only *once*, and not above fifty so often as six or seven times. Whereas Flamsteed observed most of his stars several times; above a tenth part more than ten times; many of them more than fifty, and some even more than 100: thus ν *Geminorum* was observed 103 times; *Spica* 108; γ *Geminorum* 124; *Aldebaran* 125; *Regulus* 133; η *Geminorum* 163, and μ *Geminorum* 193 times. It must be evident, then, that much that is defective in an instrumental point of view, must be compensated and rectified by the frequency of the observations; and, although eclipsed by the catalogues of Bradley and Piazzi, the author, considering the great age of Flamsteed's, regards it as possessing a degree of interest, in common with all ancient and authentic records, which ought never to be lost sight of.

He therefore conceives that it would be an object highly worthy

the attention of astronomers, to re-examine and re-reduce the original observations of Flamsteed, with the aid of all the accessions of accuracy which modern improvements have introduced in the determination of the corrections. The chief difficulty would lie in the corrections for the barometer and thermometer, which Flamsteed has not recorded. But he remarks that, should no registers of these instruments at that period and in that district be found elsewhere, no great error would arise from employing a mean state of the barometer, and adopting a scale of temperature deduced for each day in the year, from the meteorological journal of the Royal Society, from a mean of several years by night as well as by day.

It is not known at what precise period Flamsteed's catalogue was constructed; his observations were made between 1689 and 1719, and the reductions were performed between 1696 and 1708. But, besides the observations reduced and published in his catalogue, there exist in his journal a great many which have never yet been reduced at all. Miss Caroline Herschel has discovered no less than 560 of this kind, and these are probably not all. These ought to be included in any re-computation which may be set on foot.

One peculiarity in Flamsteed's mode of observation is to be considered as fortunate, not only as affording facilities for reduction, but as producing a probable exemption from many instrumental errors; viz. that it appears to have been his practice to observe in zones. Still, the task of reduction could not but be considerable. Mr. Baily, however, conceives that great benefit could not but result were it only partially executed; reducing 200 or 300 of the principal stars from the *total* observations of each star. If this were done, it would authorise a fair judgment of the value of the whole mass; and were such partial reduction attended with satisfactory results, he thinks no doubt could exist that public spirit enough would be found to support and carry through the bold and difficult undertaking he suggests. To any one who may be inclined to make the preliminary trial, he recommends as a useful aid Miss Herschel's "Catalogue of Stars, taken from Mr. Flamsteed's Observations," published by the Royal Society in 1798, which contains a list of all the stars observed by him, but not in his catalogue, as well as an index to every observation of every star, and a copious list of errata.

Mr. Baily concludes by expressing his hope that these remarks may attract the attention of some astronomer who has both talent and leisure for the pursuit of an inquiry of this kind, and who may thus become the means of restoring Flamsteed's observations to the high rank they once held, and to which it is hoped they will still be found justly entitled.

Mr. Thomas Taylor, jun., of the Royal Observatory at Greenwich, transmitted the following ephemeris of the positions of the four new planets, at their ensuing oppositions, computed by himself; at the same time remarking, that the places of Ceres and Vesta differed materially from the places as given in Bode's *Astronomische Jahrbuch.*

The computations are for the *noon* of each day.

PALLAS.			CERES.		
1827.	R	Dec. N.	1827.	R	Dec. S.
Aug. 7	22h 10m 46s	9° 56′	Sept. 6	0h 57m 23s	14° 23′
8	10 5	9 48½	7	56 50	14 30
9	9 24	9 40½	8	56 15	14 37
10	8 42	9 32	9	55 39	14 44
11	7 59	9 24	10	55 2	14 51
12	7 16	9 15½	11	54 23	14 58
13	6 33	9 7	12	53 43	15 4
14	5 49	8 58½	13	53 2	15 10
15	5 4	8 49½	14	52 20	15 16
16	4 19	8 40	15	51 37	15 22
17	3 34	8 30½	16	50 53	15 28
18	2 49	8 21	17	50 7	15 34
19	2 4	8 11	18	49 20	15 40
20	1 19	8 1	19	48 32	15 46
21	22 0 34	7 51	20	47 44	15 51½
22	21 59 48	7 40½	21	46 56	15 57
23	59 2	7 30	22	46 7	16 2½
24	58 16	7 19	23	45 17	16 8
25	57 30	7 8	24	44 26	16 13
26	56 44	6 56½	25	43 35	16 17½
8 27	55 58	6 45½	8 26	42 44	16 22
28	55 12	6 34	27	41 52	16 26½
29	54 26	6 22½	28	41 1	16 31
30	53 41	6 11	29	40 9	16 35½
31	52 56	5 59½	30	39 17	16 40
Sept. 1	52 12	5 47½	Oct. 1	38 25	16 44
2	51 28	5 35½	2	37 32	16 48
3	50 45	5 23½	3	36 40	16 51½
4	50 2	5 11½	4	35 48	16 55
5	49 20	4 59	5	34 56	16 58
6	48 39	4 47	6	34 4	17 1
7	47 58	4 34½	7	33 12	17 4
8	47 18	4 22	8	32 21	17 7
9	46 39	4 9½	9	31 30	17 9½
10	46 1	3 57	10	30 39	17 11½
11	45 24	3 44½	11	29 48	17 13½
12	44 47	3 32	12	28 58	17 15
13	44 11	3 19½	13	28 8	17 16
14	43 35	3 7	14	27 19	17 17
15	43 1	2 54	15	26 30	17 17½

VESTA.			JUNO.		
1827.	Æ	Dec. N.	1828.	Æ	Dec.
Nov. 25	5h 50m 58s	18° 43′	March 5	12h 42m 35s	−0° 38′½
26	50 10	18 44½	6	41 57	−0 31
27	49 20	18 46	7	41 18	−0 23½
28	48 28	18 47½	8	40 38	−0 15½
29	47 34	18 49	9	39 58	−0 7½
30	46 39	18 50½	10	39 18	+0 0½
Dec. 1	45 42	18 52	11	38 37	+0 9
2	44 44	18 53½	12	37 55	+0 18
3	43 44	18 55	13	37 12	+0 27
4	42 43	18 56½	14	36 28	+0 36½
5	41 31	18 58	15	35 42	+0 45½
6	40 38	18 59½	16	34 56	+0 54½
7	39 34	19 1½	17	34 10	+1 3½
8	38 29	19 3	18	33 23	+1 12½
9	37 23	19 4½	19	32 36	+1 21½
10	36 17	19 6	20	31 49	+1 30½
11	35 10	19 8	21	31 2	+1 39½
12	34 3	19 9½	22	30 14	+1 48½
13	32 56	19 11½	23	29 26	+1 57
14	31 48	19 13	24	28 39	+2 6
♂ 15	30 40	19 15	♂ 25	27 52	+2 15
16	29 32	19 17	26	27 4	+2 23½
17	28 24	19 18½	27	26 16	+2 32½
18	27 17	19 20½	28	25 28	+2 41
19	26 10	19 22	29	24 41	+2 49½
20	25 3	19 24	30	23 55	+2 58
21	23 57	19 26	31	23 8	+3 6½
22	22 51	19 27½	April 1	22 21	+3 14½
23	21 46	19 29½	2	21 36	+3 23
24	21 42	19 31	3	20 50	+3 31
25	19 39	19 33	4	20 5	+3 39
26	18 36	19 35	5	19 20	+3 47
27	17 34	19 37	6	18 36	+3 54½
28	16 31	19 39	7	17 52	+4 2
29	15 29	19 41	8	17 9	+4 10
30	14 28	19 43	9	16 27	+4 17½
31	13 27	19 45½	10	15 46	+4 25
1828.			11	15 5	+4 32½
Jan. 1	12 27	19 47½	12	14 25	+4 39
2	11 28	19 49½	13	13 44	+4 46
3	10 30	19 52			

There was next read a paper by Mr. Utting, "On a *new period of eclipses*." In this communication, Mr. Utting adverts to the well-known Chaldean periods of 223 lunations and 6890 lunations: but besides these, there are others that have been brought in aid of computations relative to eclipses. The new period, which Mr. Utting proposes, consists of 3803 lunations, or about 307 Julian years and 174 days; at the end of which time he says the sun and moon will be in conjuction at the opposite node to that from which they started: and at the end of 7606 lunations they will be in conjunction at the same node. Mr. Utting gives the secular motions of the sun's longitude and anomaly, and of the moon's longitude, anomaly, and node, from the most recent tables; from which he deduces the correct period of a mean lunation; and thence the necessary quantities for the computation of the time of the mean conjunctions.

The next papers were a series of observations by Major Hodgson: 1°. On the transit of Mercury over the sun's disc, on Nov. 4, 1822. 2°. Occultations of stars by the moon; particularly of the *Pleiades* on March 17, 1823. 3°. A set of equal altitudes for determining the time at Futty Ghur. 4°. Transits of Moon and moon-culminating stars at the same place.

Mr. Baily read the following extract of a letter from Professor Harding, of Göttingen.—"You will be pleased to hear of a small *variable* star, which I have discovered since June 9th, in last year. It is situated in *Serpens*; and my observations (which however are not very correct) give its position for 1800, as follows:

$$\text{R} = 235^\circ\ 22'\ 3'' \qquad \text{D} = +\ 15^\circ\ 44'\ 48''$$

It has at this time its greatest light; and will soon begin to diminish. As far as I have yet observed, its period seems to be about eleven months. This star is neither in the *Histoire Céleste*, nor in Bessel's *Zones*: nor have I observed it before the year 1826. When smallest, it is *entirely invisible*."

A letter was read from Mr. George Innes, of Aberdeen, giving the results of his computations relative to the solar eclipse of the 28th of November last. He states, that in calculating the parallaxes in longitude and latitude, he used the method of the Nonagesimal, and went over the process for each of the places, both according to the method used by Dr. Brinkley, and to that of Delambre. The difference in the results did not, in any case, exceed three-tenths of a second. For the reduction of the latitude, and equatorial parallax, the compression $\frac{1}{300}$ was used. No corrections were applied to the semidiameters of the sun or moon, for irradiation or inflexion. The augmentation of the moon's semidiameter for each of the places was obtained from Delambre's formulæ *only*. The following are the observations used in the computations, which are all expressed in *mean time*. In computing the Greenwich observation, he adopted that which was made with the five-feet equa-

torial; but it appears from the observations made at other places (except Dublin) that some of the others are nearer the truth.

Bushy Heath =	28d	21h	46m	4s,0	beginning
	28	23	58	19,0	end.
Epping .... =	29	0	0	54,0	end.
Greenwich.. =	29	0	0	11,5	with 25 inch achrom.
	..	..	..	12,4	with 46 inch do.
	..	..	..	13,4	with 5 feet equat. } end.
	..	..	..	16,5	with 30 inch achrom.
	..	..	..	18,0	with 7 feet Newt.
Dublin .... =	28	23	25	30,0	end.
Armagh .... =	28	23	24	10,8	end.
Aberdeen .. =	28	23	49	45,1	end.

From these observations Mr. Innes obtained the following results:

	Conjunction Nov. 28. *Apparent* time.	Longitude.
Bushy Heath *b*	23h 35m 50s,66	
Bushy Heath *b* & *e*	35 50,19	
Bushy Heath *e*	35 47,64	1m 25s,57 W.
Epping	37 38,08	0 24,87 E.
Greenwich	37 13,21	
Dublin	11 51,40	25 21,81 W.
Armagh	10 34,23	26 38,98 W.
Aberdeen	28 48,30	8 24,91

The results deduced from the observations at Bushy Heath marked *b*, *b* and *e*, and *e*, are obtained from the *beginning* of the eclipse, from the *beginning and end* conjointly, and from the *end*. And from *these* observations Mr. Innes obtains +9″,68 for the error of the tables in longitude, and —2″,44 for the error in latitude. The lunar tables made use of were the recent ones of M. Damoiseau: and Mr. Innes has subjoined to his paper the whole of the elements employed in the calculations.

A description of an instrument called a *Tangent Sextant*, intended to determine the distances of objects from an observer, when their distances from each other are known, was communicated to the Society by Captain John Ross, R.N., who states that it was invented by an eminent land-surveyor, who lived to finish but two of them; and Captain Ross has since made some improvements in the instrument.

The index-mirror is placed diagonally across the bar of the index, having the centre in a line with the front edge of the index; and, in observing, the telescope is so placed that the centre of the instrument is towards the observer, and the limb directed towards the

objects, which are brought in apparent contact, as in other reflecting instruments. The edge of the revolving index intersects another fixed and graduated radius, passing through the zero of the limb; and the figures at the point of intersection indicate the number of times which the distance of the objects from each other is contained in the distance of the observer from the nearer of them, *when the angle at the nearer object is a right angle*, the only case of the problem which, in this application of his instrument, the inventor appears to have had in contemplation.

A method of making the necessary computations for deducing the longitude from an occultation of the moon, by Lieut. C. R. Drinkwater, R.N. was read. In the method proposed by Mr. Drinkwater, the sun's right ascension, and the moon's declination, horizontal parallax and semidiameter, are taken from the Nautical Almanac for the approximate Greenwich time; and the star's meridian distance being found, the latitude and parallax are corrected for the earth's ellipticity.

Then, calling the reduced horizontal parallax P, the star's meridian distance M, its polar distance p, and the latitude l; he computes arc A, from $\tan A = \cos M \cdot \cot l$; arc B, from $B = p \pm A$; C, the principal effect of parallax in polar distance from $C = P \cdot \sin l \cdot \sin B \cdot \text{sect } A$, (— when A is less than p, otherwise +, unless M exceeds 6^h, when it is always —); D the parallax in right ascension from $D = P \cdot \cos l \cdot \sin M \cdot \text{cosect } p$ (—when the star is east of the meridian, otherwise +); and E, the final correction of declination from $E = \frac{D^2 \cdot \sin 2p}{\sin 1''}$ (always —). And having thus found the declination of the point of occultation, the difference between it and that of the moon's centre is known; and from this difference, the moon's semidiameter, and the declinations of both objects. Mr. D. computes in the usual way the difference between the right ascension of the planet, and hence finds the right ascension of the moon's centre; from which, by interpolating in the Nautical Almanac, he finds the Greenwich time.

The business of the evening being concluded, Professor Amici (one of the Associates of the Society), at the request of the President, obligingly permitted the inspection of several instruments of his invention and workmanship. The principal were, a new compound achromatic microscope, a reflecting circle on a new construction, and a prismatic reflecting sextant. The microscope is formed with three achromatic double object-glasses, applied separately, or in combination; their common axis is directed vertically downwards, and the refracted pencil is turned into a horizontal position by internal reflexion at the base of a right-angled prism, for the convenience of observation, and after passing along the axis of a tube about seven inches long, received on the eye-piece. The object is powerfully illuminated from below by the reflected light of an Argand lamp, or daylight, collected in the focus of a large concave mirror. Several objects were viewed, such as the feathers on the wing of a

butterfly, the pollen of the mallow, &c., which were shewn with the utmost distinctness and beauty with powers of 700 and 1500* (the latter as stated by Mr. A. to have been determined by himself in conjunction with M. Arago in Paris).

The reflecting circle consists of two circles, of about six inches diameter, revolving one within the other, the outer of which carries the verniers, on which the divisions of the inner are read off to 20″. To each of these circles, in a plane perpendicular to its own, and intersecting it in an exact diameter, is attached a long narrow plane reflector, in breadth equal to half the object-glass of the telescope, and in length, nearly to a diameter of the circles, and so contrived as to lie wholly below the plane of the limb, or at the backs of the circles, and to have their edges almost in contact, and intersecting exactly in the prolongation of the common axis of both circles; by which means parallax is avoided, and the necessity of a reduction to the centre, when the angles between near objects is taken, obviated. The attachment of these reflectors to the circles, so as to preserve the requisite freedom of motion and stability of the centre-work, is performed by a frame-work easier to imagine than to describe without a figure. The telescope is attached to the limb of the vernier circle (which is either held in the hand by a proper handle, or supported on a pillar and counterbalanced). Its object-glass is covered half by one of the reflectors and half by the other; and the images of two objects seen by reflection in each, being brought to coincide, it is manifest that the angle between the reflectors (which is equal to half the angle subtended by the objects at the centre of the instrument) will be read off on the divided limb. The principal advantages offered by this construction are, the avoiding of parallax, and a power of measuring the same angle on four different parts of the limb (independent of the four readings of the verniers).

The prismatic reflecting sextant is nearly on the same principle, only that the internal reflexion at the bases of right-angled glass prisms is here employed in the place of metallic or silvered glass mirrors. It has, we believe, been described in the *Correspondence Astronomique* of Baron Zach, for which reason it is unnecessary to give any further account of it here.

* These powers, however extraordinary they may seem, are not exaggerated. The writer of this notice has since, more than once, witnessed, and taken part in, the determination of several of the powers of the microscope in question, under various combinations, in the presence of M. Amici himself, and several gentlemen of the greatest experience in such trials; when the results for four combinations tried were respectively 300, 700, 1120, and 3159 (all for *linear* measure). With the last enormous power, vision was still *tolerably* distinct, though necessarily very obscure: with all the others admirably perfect.

J. Moyes, Castle Street, Leicester Square.

ASTRONOMICAL SOCIETY OF LONDON.

November 9, 1827. No. 6.

Mr. Baily presented a paper "On the right ascension of γ *Cassiopeæ*." As this paper is a short one, and of an interesting nature, we shall give it nearly in the words of the author:

"On comparing the Catalogue of Stars, recently published by this Society, with the catalogue of 100 principal fixed stars given by Mr. Pond, at the end of the *Nautical Almanac* for 1829, I was struck (he says) with the considerable difference which appears in the $\mathcal{R}$ of γ *Cassiopeæ*: Mr. Pond making the $\mathcal{R}$ of that star upwards of one second (in time) more than the catalogue printed by this Society. At first I imagined that some error might have crept into the calculations of the Society's Catalogue, notwithstanding they were made by two computers, independent of each other, and afterwards revised by our indefatigable Secretary, Mr. Stratford. I therefore, for my own satisfaction, went through the whole computations myself, and was pleased to find that there was not the slightest difference in the results. I next reduced the whole of the observations of that star made by Mr. Pond at the Royal Observatory at Greenwich, and found them to agree very nearly with the result deduced by Mr. Taylor, who makes the mean of 10 observations to be $= 0^h\ 46^m\ 13^s,23$ reduced to Jan. 1, 1825: whereas the Society's Catalogue gives only $0^h\ 46^m\ 12^s,13$ on January 1, 1825; being a difference, as already stated, of $1^s,1$. Bradley has 5 observations of this star, and Piazzi has 46. It is scarcely possible that Bradley should be in error one second of time; and still less probable that the mean of 46 observations by Piazzi should be erroneous to such an amount. The result of Bradley's observations (after allowing for the effect of precession) differs $8'',5$ in space from those made by Piazzi; which quantity, divided by 45 (or the interval of years between the two observers), will make the annual proper motion of the star, if it really have any, about $0'',19$ in space. But this is not confirmed by the recent observations of Mr. Pond; and we must look elsewhere for a solution of the difficulty. That the position of a star of the third magnitude should be so undecided at the present day that its $\mathcal{R}$ cannot be satisfactorily depended on, to a second of time, does not speak much in favour of modern astronomy; and shews us that a great deal still remains to be done towards establishing the *fundamental* parts of the science. * * * Amongst other suggestions I have imagined that it might arise from a typographical error; and, in fact, if we suppose a misprint of 10″ in the $\mathcal{R}$ of γ *Cassiopeæ* in Piazzi's Catalogue, that is, if we read $\mathcal{R} = 11^\circ\ 11'\ 17'',6$ instead of $11^\circ\ 11'\ 7'',6$, the whole difficulty will vanish, and the results of the observations of Bradley, Piazzi, and Pond, will agree to the greatest exactness.

But we are scarcely warranted in making such an alteration without a reference to the original observations. Some suspicion, however, is excited that the printing is not strictly correct, from the circumstance that Piazzi considers the annual proper motion in $\mathcal{R}$, as deduced from Bradley's observations, to be $= 0$; which would agree with the amended reading as here suggested; but which does not accord at all with the present reading in the Catalogue, since the annual proper motion is, as I have already observed, in such case $= -0'',19$.

" Before I close these remarks, I would observe that there are also differences in the $\mathcal{R}$ of three other principal stars (besides that of β *Scorpii*, which is acknowledged to be an error in the Greenwich catalogue) to which I am desirous of calling the attention of the Society; and for which I can by no means account. These are ζ *Ursæ Majoris* and β *Cephei* (both stars of the third magnitude) and *c Draconis*, a star of the fifth magnitude. The two last differ, as in the case of γ *Cassiopeæ*, above a second in time from the catalogue of Mr. Pond: but ζ *Ursæ Majoris* differs as much as $1^s,4$. The case of this last star is the more remarkable, since the observations of Bradley and Piazzi correspond with wonderful exactness; there being a difference of only one second, in *space*, between them, after a lapse of 45 years: whereas from the time of Piazzi to the year 1825, a period of only 25 years, there appears, from Mr. Pond's observations, to be a difference of upwards of $20''$.

" The whole of the computations relative to the positions of these stars, I have frequently repeated, and can assure the Society that there is no error in the results, as printed in their catalogue. Time only, and further observations, can clear up these apparent difficulties."

A paper was read " On Double Object-glasses, by M. Littrow."

The first part of this communication is devoted to the derivation of the equations expressing the conditions proposed by Mr. Herschel for the destruction of the aberration of sphericity in a thin double object-glass, by the ordinary processes in use among the German geometricians for such investigations. The author states himself to have entered on this investigation with a view to disseminate a knowledge of the theory alluded to in his own country; but being induced thereby to resume some former investigations of his own, he takes the opportunity to communicate to the Society his own principal results.

Taking for granted the well-known expression of Euler for the aberration of a lens of two surfaces, and developing it in descending powers of the distance of the radiant point from the lens, he obtains expressions, from which, by proper management, and substitution of similar quantities for a second lens, he derives the two final equations (A) and (z) demonstrated by Mr. Herschel. He then proceeds to the main object of his paper. This may be briefly stated to be the embodying of the relations expressive of the refraction of a ray through any four spherical surfaces, however situated,

(provided they have a common axis), in trigonometrical equations, in which no quantity is regarded as small, and of course nothing neglected. These equations are in themselves sufficiently simple when undeveloped, and in that state may very readily be applied to determine whether any proposed construction of an object-glass really does satisfy the essential geometrical conditions of a perfect telescope, by producing a rigorous union of different coloured rays, and rays incident on different parts of the object-glass. Accordingly the author instances their application to a construction recently proposed by a German optician, as of peculiar excellence. In this construction the indices of refraction of the crown and flint lenses being respectively 1·53 and 1·60, and their dispersive ratio 0·25, the thickness of the crown lens 0·1, that of the flint 0, and the lenses being supposed in contact, the radii of the surfaces are,

For the crown	1st surface (convex)	0·69281
	2nd surface (convex)	2·255319
For the flint	1st surface (concave)	1·543030
	2nd surface (concave)	5·768005

Substituting these data in his equations, he finds that they satisfy sufficiently well the conditions of achromaticity, but that they are very far from being entitled to the same encomium when the spherical aberration is considered.

But when the question is inverted, and the problem is, not to try whether a proposed construction be good or not, but, *à priori*, to determine what is best, the equations in question, though simple enough in their trigonometrical form, become complicated by the algebraic developements their direct analytical resolution necessitates. Now the essence of M. Littrow's proposed method is to do away with all this developement, so far as it tends to produce complication; and after preparing the equations in the most convenient manner the case will allow, to substitute for their direct algebraical, an *indirect numerical* solution, by the well-known and ready method of trial and error, a method perfectly correct in theory as well as easy in practice.

M. Littrow exemplifies this theory by applying it to that particular case when the indeterminate problem is limited by the condition of Klügel, viz. that the refractions at the first two surfaces shall be as small as possible, in which case the first or crown lens is in fact wholly given, and it only remains to determine the radii of the flint. He takes into consideration the thickness of the former, but not the latter lens, and neglects also their distance *inter se*. As a numerical instance, he supposes the indices of refraction 1·53 and 1·58, the dispersive ratio $\frac{2}{3}$, and the thickness of the crown lens one hundredth part of its focal length, when, by applying the process described, he finds the following radii:

Crown lens..	1st surface (convex)	0·186823
	2nd surface (convex)	0·608170
Flint lens...	1st surface (concave)	0·407996
	2nd surface (concave)	0·445808

Focal length of the compound lens = 1; aperture 0·06495

M. Littrow, however, is by no means of opinion that the condition of minimum refraction here assumed is the best, or in any way essential to a good object-glass; only it facilitates calculation. He regards it as more advisable to aim at increase of aperture, and for this purpose to assume the first or crown lens equiconvex, which he affirms to be the condition requisite for the attainment of that end. He therefore explains his method of proceeding in this case, and applies it to the same numerical data with those last mentioned, which give for the final results:

Crown lens (equiconvex) Radius of each surface .. 1·06
Flint lens (biconcave) Radius of 1st surface ... 1·04394
of 2nd surface ... 3·296512

Focal length.. 3·702231
Aperture..... 0·09973 × focal length

or nearly $\frac{1}{10}$ of the focal length, being a much larger proportional aperture than it has been usual hitherto to give to achromatic telescopes.

The author concludes by stating the reason of his entering into these investigations, viz. an application made to him by an artist of Vienna.

A paper was also read from M. Slawinsky, containing the following observations made at Wilna. (Longitude $1^h\ 41^m\ 12^s$ East of Greenwich.)

1. *Eclipses of Jupiter's Satellites.*

			Sidereal time.	
1825. Jan. 17	Im. 1 ..	$4^h\ 0^m 23^s,7$	good observation.
Mar. 22	Em. 2 ..	8 51 51 ,9	very good.
Apr. 23	Em. 1 ..	10 44 25	good enough.
May 5	Em. 1 ..	12 29 38 ,7	very good.
1826. May 8	Em. 1 ..	15 31 56 ,1	middling.
June 2	Em. 2 ..	16 46 0 ,1	middling.
1827. Mar. 18	Im. 1 ..	16 1 14 ,9	a little doubtful.
Apr. 18	Im. 1 ..	16 46 15 ,2	passable.

2. *Occultations.*

			Sidereal time.	
1825. Apr. 1	*e* Leonis ...	Im.	$10^h\ 8^m 55^s,2$	very precise.
		Em.	11 15 14 ,2	a little doubtful.
23	Star (mag. 8·9)	Im.	11 22 29	exact.
1826. Feb. 15	208 Tauri	Im.	6 55 58 ,8	good.
16	Saturn			
	1st ansa	Im.	3 11 58 ,8	good.
	1st limb		3 12 8 ,8	
	2nd ansa		3 14 48 ,3	
1827. Mar. 18	λ Libræ.....	Im.	17 4 55 ,9	good enough.

J. Moyes, Castle Street, Leicester Square.

ASTRONOMICAL SOCIETY OF LONDON.

December 14, 1827. No. 7.

A LETTER was read from Major Hodgson, the Surveyor-General of India, dated from Calcutta, April 18, 1827, accompanied by two copious lists of astronomical observations. The *first* contained a series of transits of the moon and some of the principal fixed stars, as observed at his own house (situated 5 seconds in time, east of the Flag-staff of Fort William) from November 18, 1826, to March 20, 1827, both inclusive. The observations are above 300 in number; and the stars observed are not those which are usually denominated moon-culminating stars, but consist of some of the principal stars only; and many of these situated occasionally at very considerable distances from the moon in declination. In fact, the list of moon-culminating stars has never yet been computed early enough, to enable it to be sent to such distant places, in sufficient time for the observations. It is therefore to be feared that correspondent observations of many of the stars observed by Major Hodgson may not be found at the observatories in Europe. The results of the transits are regularly computed by Major Hodgson, agreeably to a printed form, where every step of the process is minutely laid down, and of which he has forwarded to the Society two examples. It is Major Hodgson's intention to continue his observations for one whole year at least, and to transmit them to the Society, together with the daily computations shewing the results. The instrument employed was a 31-inch transit by Dollond; but he is in expectation of a more powerful one shortly from England. The *second* list contained a series of upwards of 200 observations of the eclipses of Jupiter's satellites, taken by gentlemen in the civil service, and by officers of the Bengal army, at different times and at different places. The dates extend from July 18, 1795, to April 11, 1827; and the names of the observers are given, together with the length, the aperture, and the magnifying power of the telescope employed. Major Hodgson states that he shall transmit several others as soon as he can collect them; for (he observes) "observations of this kind have been of much use in determining geographical positions in this widely extended country; and the probability of obtaining correspondent observations through the medium of the Astronomical Society, will excite travellers and surveyors to take advantage of all opportunities of making observations of the eclipses of the satellites of Jupiter, and of the culmination of the moon and stars."

A paper was also read, entitled "On the computation of the geocentric places of the planets for ephemerides:" by J. F. Littrow.

The usual mode of computing the geocentric places of the planets for ephemerides consists in instituting a first computation of their heliocentric positions, which are then reduced to geocentric, by well known formulæ. To avoid the very laborious calculations entailed by this process, Prof. Gauss devised a method much more expeditious, and which gives at once the geocentric right ascensions and declinations, as well as the distance of the planet from the earth, in terms of the co-ordinates of the earth and planets at the instant of observation. The equations expressive of these relations are stated by M. Littrow, and are extremely simple. By them, the right ascension (α), the declination (δ), and mutual distance (ϱ) are given directly as follows:

$$\tan \alpha = \frac{Y + y}{X + x}$$

$$\tan \delta = \frac{Z + z}{X + x} \cdot \cos \alpha \qquad \text{(I)}$$

$$\varrho = \frac{Z + z}{\sin \delta}$$

X, Y, Z being the co-ordinates of the earth, and x, y, z of the planet.

Now it is obvious, that if we neglect the perturbations (on which neglect, it will be observed, the application of this method mainly depends), all these co-ordinates are, ultimately, functions respectively of the mean longitudes of the earth and planet, and their values may therefore be tabulated as such; and the tables, once constructed, will last till the secular variations of the elements of the planetary orbits shall have so changed them as to produce an error surpassing that which can be tolerated in an ephemeris. These tables once computed, the foregoing equations reduce the annual computations to the utmost brevity. The only point then to consider is the construction of the tables themselves.

The expressions of the co-ordinates in terms of the mean longitude are made to depend on the true longitude as the independent variable, by means of six constant quantities for each planet. These are, 1st, the respective inclinations of the plane of the planet's orbit to the solstitial and equinoctial colures and the earth's equator; and, 2ndly, the plane angles made by the line of intersection of the planet's orbit, and the ecliptic respectively with its line of intersection with the solstitial and equinoctial colures and equator. The author states the method of computing these constants from the known elements of the orbit, and gives their actual numerical values for all the planets, with their secular variations. These once known, and the true longitude, as a preliminary step, computed for every mean longitude, he states the equations by which the co-ordinates are formed from them for every given value of the longitudes; and, finally, embodies the whole result of his computations in a table stating their values for each of the planets, and for intervals of 4° for Mercury and Venus, 3° for Mars, 2° for Jupiter, Saturn, and Uranus, and for each day in the year for the Sun.

The publication of the 1st Part of the 3d Volume of the Memoirs of the Society was announced by the President.

At the conclusion of the business of the evening, an instrument, contrived by Mr. Henry Atkinson, of Newcastle-upon-Tyne, to illustrate some of the phenomena of rotation, was submitted to the inspection of the members by Mr. Riddle. It consists of a flat circular disk, through the centre of which passes a small endless screw, having a cup in one of its extremities. When the cup is *below* the centre of gravity, and set on a point on which the disk (inclined to the horizon) is made to rotate in its own plane, the whole rotating plane performs at the same time a slow revolution round the perpendicular to the horizon, which passes through the point of rotation; and the revolution of the plane is in the *same* direction as the rotation. When the point of rotation is *above* the centre of gravity, the plane moves slowly round in a direction *contrary* to that of rotation, affording an apt *illustration* of *precession*. When the point of rotation is *in* the centre of gravity, the position of the revolving plane continues permanent.

J. Moyes, Castle Street, Leicester Square.

ASTRONOMICAL SOCIETY OF LONDON.

January 11, 1828. No. 8.

THERE was read a paper entitled "Third Series of Observations with a 20-feet reflecting telescope; containing a Catalogue of 384 new double and multiple stars, completing a first thousand of those objects detected in sweeps with that instrument; together with Observations of some previously known." By J. F. W. Herschel, Esq., President of the Society.

This paper, as its title imports, is a continuation of the two papers previously communicated by the author on the same subject. The field of discovery in this department of astronomy, though narrowed by the great work recently published by Professor Struve, the author considers as not yet exhausted; since, on an average of the part of the heavens swept by him, not above one in four, of double stars sufficiently remarkable to attract attention in sweeping, have been catalogued by the eminent astronomer last named; not to mention the vast number of interesting close double stars, below the 9th magnitude, which a minuter examination than the nature of his sweeps permits, would no doubt produce. The double stars of this Catalogue, he observes, are considerably more *select* than those of his two former ones; those whose distance exceeds 32″ being (except in particular cases) excluded, and the limit of distance being narrowed according to the faintness of the component stars.

The author prefaces his Catalogue with a comparison of the magnitudes habitually assigned to the stars by himself and Professor Struve; from which it appears that, on the average, his magnitudes have a denomination about one unit lower than those of that astronomer;—a star (for example) which M. Struve would call of the 9th magnitude, being, in Mr. Herschel's nomenclature, of the 10th. The limit of vision in the Dorpat telescope he presumes to lie about his average 14th magnitude, though such a determination must necessarily be liable to some latitude. This conclusion he deduces from a series of instances, in which small companions have been seen by him attached to large stars, within the limits of Professor Struve's 4th class, which have escaped the notice of the latter.

The author then states the principle on which he estimates magnitudes below the 6th, which is that of continual bisection of the light; and he cites some experiments, by which it appears that the light of an average star of the 1st magnitude is at least 150 times that of the 6th. He then adduces a series of observations of a considerable number of the closer stars of M. Struve's Catalogue, by which it appears that the Slough telescope easily defines, with its

ordinary sweeping power, the generality of M. Struve's stars of the 1st class, and many of those marked by him as *vicinæ*, and even *pervicinæ*; but those which have the epithet *vicinissimæ*, he has not yet succeeded in separating with the highest power (240) usually applied,—which indeed was to be expected. In lieu of M. Struve's classification of double stars, which he considers as enlarging beyond due limits the number of those of the 1st class, he proposes the following system, which, in fact, very nearly approximates to that originally followed by Sir William Herschel.

Class I.	close	0″ and below	1″
	not close	1 and below	2
Class II.		2 and below	4
Class III.		4 and below	8
Class IV.		8 and below	16
Class V.		16 and below	32
Class VI.		32 and below	64

So that the limit of distance of stars of the nth class shall be $2^n \times 1''$.

The author then subjoins a list of stars common to his two former Catalogues and to that of Professor Struve, 86 in number; after which he proceeds to describe some singular phenomena observed in the course of his examination of these objects, which explain certain discrepancies between the results of observations of their angles of position on different nights, and which tend to throw light on some obscure points in the theory of vision. He considers it as rendered very probable, by some of the facts adduced, that time is required for light to make an impression on the retina, as well as for the impression made to wear off; and that this time is the less the brighter the object; and explains by this principle a remarkable degree of unsteadiness and fluctuation observed in the limb of the planet Mars, while small stars in the field remained perfectly tranquil, as well as certain other curious phenonema.

He then adds some observations on the contrasted colours so frequently observed in double stars, and regards them as (at least) in many cases referable to the laws of vision; in virtue of which, a strong light having an excess of the less refrangible rays, will cause a feebler one, in which no such excess exists, to appear of the complementary hue; instances of which, in artificial lights, are adduced. He notices especially the extremely intense red colour of a star of the 8th magnitude, R.A. $4^h\,41^m$. N.P.D. 61° 47′ (1828).

These prefatory remarks are terminated by some observations of the 5th star *in trapezio nebulæ Orionis*, pointed out by M. Struve. The author adduces evidence, which he considers as satisfactory, that no such star existed in that situation on the 13th March, 1826. It was observed, however, by M. Struve, to be conspicuous on the 11th Nov. of that year. It is now readily seen in the Slough telescope; and at the time of drawing up the present paper, it was so bright as not to be overlooked with the most ordinary degree of attention. He considers it, therefore, if not as a NEW STAR, at least as a variable one of very singular character.

The Catalogue, which follows, is arranged in all respects like the preceding ones published in the Memoirs of this Society, and is followed by a list of about 200 double stars, for the most part found in the same sweeps with the others; but which, occurring in M. Struve's Catalogue, cannot now be regarded as new double stars. Their observed places and estimated angles of position, distances, and magnitudes, are however given, in order to afford ground of comparison between the two Catalogues, of which comparison the results are stated.

J. Moyes, Castle Street, Leicester Square.

ASTRONOMICAL SOCIETY OF LONDON.

February 8, 1828. No. 9.

Report of the Council of the Society to the Eighth Annual General Meeting, held this day.

Your Council are happy in being able to commence this, their Eighth Report, with a general expression of congratulation on the progress of the Society, and on the prospects of increased and increasing utility, which a view of its actual state and resources, and a consideration of the events of the year now closed, in their minds, appear to justify. They trust, too, that a review of these events will at the same time justify the confidence reposed in them, by shewing that they have not been neglectful of the opportunities which have offered, of advancing in various ways the objects and interests of the Society.

One of the first acts of the Council of the year elapsed, was to enter into an arrangement with Mr. Taylor, the printer to the Society, and who is also one of the editors of the Philosophical Magazine, for the publication of a series of monthly notices of its proceedings, and for the supply of a sufficient number of copies of them, in succession, for distribution among the members. The convenience and advantages of this plan have been sufficiently proved by the trial which has been given it, and it will of course be continued. The public is hereby brought more immediately into contact with the Society — the labours of its contributors are canvassed and discussed, while the interest of the author in his subject is yet warm, and when the interchange of ideas respecting it is most beneficial, not only to the public, but to the author himself, whose views may, and probably in many instances will, be enlarged or corrected by such intercourse. An authentic, and at the same time public, record is, as it were, opened, of the papers read, and the outlines of their contents rendered matter of history; — thus affording ready means of establishing the claims of authors to priority of discovery, so far at least as priority of public communication can be regarded as evidence in questions of that nature. The same arrangement offers the further advantage of relieving the Council from all difficulty in the disposal of matter of merely temporary interest; such as notices of phenomena, ephemerides of the smaller planets, comets, &c. which require speedy circulation, and do not need to be formally enrolled in the *Memoirs;* and it may occasionally happen, that the matter of more regular communications may so far be condensed into the monthly abstract, as to dispense with a second publication in the Memoirs — to the material relief of the funds of the Society.

The same consideration of the advantages derived from the

speedy publication of communications read to the Society, has induced the Council to adopt the principle of sending immediately to press all papers which, on passing through the prescribed formalities, shall be deemed of a nature for publication in their Memoirs; and although objections have been considered to exist against the separate publication of each particular memoir, the division of their volumes into smaller parts can be attended with no inconvenience. Acting on this principle, the Council have directed the publication of Part I. Vol. III. of the Memoirs, including all papers (regarded by them as suitable for printing in the body of the Memoirs) read during the interval elapsed from the last publication. This Part is now, accordingly, before the public, and furnishes satisfactory proofs of the zeal, diligence, and talents, both of our Home Members and our Associates.

It is not merely, however, in communicating to the world the observations of their members, but also in causing observations to be made, and in lending every assistance in their power to those meritorious and public-spirited individuals, who, actuated only by an earnest desire to render available their leisure and talents in the cause of science, are willing to undertake the task of regular observation,—that a Society like this can render service to science. The munificent act of a private individual has happily placed this particular line of utility more directly than heretofore in the power of the Society; and its members have not been slow in availing themselves of its advantages, and applying them to effective use.—Among the great and lamented losses which the Society has sustained in the course of the last year, is that of the late Colonel Mark Beaufoy; the latter days of whose existence we recollect, with a melancholy pleasure, to have been cheered and gratified by the highest mark of this Society's approbation, in the award of their medal for his astronomical observations. His son, Lieut. George Beaufoy, has, with the utmost liberality, placed his deceased father's astronomical instruments in the possession of this Society. It would be doing an injustice to the public spirit and good feeling which have dictated this act, not to record it in his own words. The following, then, is a copy of the letter, announcing the donation.

Bushy Heath, 5th June, 1827.

Sir,—My father, Colonel Mark Beaufoy, has bequeathed his principal instruments to me; an arrangement in which I am confident he has consulted my feelings rather than his own inclination.

Permit me then, Sir, in his name, to offer these instruments to the Astronomical Society.

Should the President and Council honour me by the acceptance of this offer, be pleased, Sir, to assure them, that Colonel Beaufoy never flattered himself that the gift would be worthy of being presented to so scientific a body; but he nevertheless continued, until the latest hour of his life, to take an intense interest in the prosperity of the Astronomical Society,—doubly endeared to him by the association of valued friends, and by the sincere conviction which he felt, that the success of the Society

was pre-eminently identified with the general diffusion and advancement of the science of astronomy.

I have the honour to remain,
Sir,
Your very obedient, humble servant,
G. BEAUFOY.

W. S. Stratford, Esq.
Secretary to the Astronomical Society.

The instruments consist of
One 4-feet Transit, by the late Mr. Cary, Strand.
One Altitude and Azimuth Circle, by the same.
One Clock, adjusted to mean Solar time.
One Clock, adjusted to Sidereal time.

Your Council conceive, that the opportunity fortunately placed before them, by Lieut. Beaufoy's recent election as a member of this Society, of marking their sense of this liberal and public-spirited conduct on his part, by a high and complimentary distinction, ought not to be neglected. They have therefore thought it advisable to recommend to the Society to elect him a member for life.*

The Council wish to observe, with respect to the measure so recommended, that though it may seem equivalent to the acknowledgment of a class of members similar to that which, in the constitutions of some scientific bodies, are deemed honorary members,—yet they are rather desirous to avoid the establishment of purely complimentary distinctions, and to mark by it, in this and any future case which may occur, the Society's sense of some distinct benefit accruing to itself or to astronomical science, through the individual so distinguished, which could not be properly acknowledged otherwise;—thus leaving every future case to rest on its own individual merits, as if it were the first of its kind.

The surest criterion of the utility of a donation is its immediate and effective practical application. That of Lieut. Beaufoy was scarcely announced to the Council, when an application was made to them by one of our members, Captain Smyth, R.N. (justly distinguished for his knowledge of the resources of practical astronomy), for their loan, which was immediately accorded; and the Council have the high satisfaction of being able to announce to you, that the instruments in question are at this moment (with the exception of one of the clocks) mounted in the best manner, in a regular observatory established by Captain Smyth, at his residence at Bedford, for their express reception, and already in actual use in celestial observation. The Council, though not unaware of the general nature of Captain Smyth's astronomical views, purposely forbear from publicly stating at present the course of observations in which he purposes to engage; being desirous to leave his meritorious exertions as far unfettered as possible by any public pledge — and trusting rather to his high character and well-known zeal, talent, and activity, than to any express stipulation, that the means thus placed in his hands will be exerted for the advancement of astronomical science.

* [A Resolution to this effect was unanimously adopted at a General Meeting.—SEC.]

Actuated by a similar desire to promote, as far as our means will admit, the great objects of astronomical inquiry in all its branches, the Council have ordered two invariable pendulums, of iron and of copper, on a construction somewhat different from those hitherto employed, to be consigned to Captain Foster, for the purpose of investigating the possible effect of the earth's magnetism in various geographical positions, in these delicate researches, in the course of his approaching scientific voyage; an enterprise which honourably characterises the enlightened views of government, and from which a rich harvest of important results may be anticipated.

From the report of the Finance Committee it appears that the funds of the Society continue in a flourishing state, notwithstanding the heavy demands for computation and printing during the last year. This extraordinary expenditure has principally arisen from the great expense incurred in publishing the Catalogue of the principal fixed stars, alluded to in the last Report, and which appears to have met the approbation of every astronomer. But the Council are happy to state, that this disbursement has been followed by a corresponding spirit of zeal and liberality on the part of several of the members, who, by entering into a subscription, have enabled the Council to defray nearly the whole expense of that useful and valuable work, without intrenching on the ordinary funds of the Society. And it may be mentioned, as a proof of the liberal spirit which animated those members, that the sum of 320*l.* was subscribed, within a few hours, towards the expense of publishing the Catalogue above alluded to.

The following brief abstract of the last year's accounts will shew that the state of the funds of the Society is such as to be a source of congratulation to the members.

Cash received.	£.	*s.*	*d.*
Balance last year ...	169	19	3
Resident members ..	228	18	0
Non-resident members	63	0	0
Compositions	37	16	0
Dividend on 800*l.* consols	24	0	0
Do. on 857*l.* 3*s.* 8*d.* 4 per cents.....	34	6	0
Sale of Memoirs....	149	11	5
Subscription to Catalogue	320	0	0
	£1027	10	8

Cash paid.	£.	*s.*	*d.*
Composition invested	25	4	0
Medals	28	1	7
Printer's bill	612	19	2
Rent	52	10	0
Sundry disbursements	65	6	8
Balance..	243	9	3
	£1027	10	8

The balance of 243*l.* 9*s.* 3*d.* consists of 144*l.* 8*s.* 10*d.* in the hands of the Treasurer, and 99*l.* 0*s.* 5*d.* due from the publishers, for books sold. This is properly the Cash Account of the Society; but there are a few other items outstanding, not included in the above, the balance of which is, however, in favour of the Society. For instance, there is still due to the printer the sum of 147*l.* 2*s.* 6*d.*: but, on the

other hand, there are some arrears of subscriptions not yet collected, which amount to 189*l.* This balance, together with the stock of Memoirs still unsold, will therefore increase the real value of the property of the Society.

The Council cannot too earnestly impress on the attention of the members, the necessity of encouraging the sale of the Memoirs as much as possible; since it is only by a quick return, arising from such sale, that they can expect to continue the publication, from year to year, without a serious diminution of the funds of the Society.

It appears from this Report that the total number of our members now amounts to 214, and of our associates to 32.

Among the accessions to our home list of members, in the year elapsed, the Council have to record, with all those sentiments of respect which his illustrious rank so peculiarly inspires, the name of His Royal Highness the Lord High Admiral; and they trust that this accession, so honourable in itself, and so gratifying to the Society, will be attended with the most beneficial results to the science which this Society was formed to promote, and which is so intimately connected in its practical application with the department over which His Royal Highness presides. Our home list has been further increased by the accession of fourteen new members, and our foreign, by that of one associate.

Among the losses sustained by death, the Society has to lament, in addition to Colonel Beaufoy, that of its most illustrious associate, Laplace: and on our home list, of the Rev. Lewis Evans; His Grace the Duke of Gordon; our amiable and excellent trustee, Mr. Daniel Moore (whose loss will be felt far beyond the limits of this body by many, as the privation of a benefactor, in whose ears the calls of distress never sounded in vain); Mr. W. M. Mosely; and Mr. J. Sanders.

Mr. Mosely, in addition to a competent knowledge of various sciences, had turned much of his attention, in the latter part of his life, to astronomy. He possessed several valuable instruments, and is said to have left behind him a series of observations of transits and north polar distances, and some measures of double stars confirmatory of their changes.

Mr. Evans also possessed instruments of considerable merit, and for several years employed himself as a skilful and successful observer.

It will not be expected that any sketch should here be attempted of the labours of M. de Laplace. No history of his scientific life, of the origin and developement of his views, adequate to the occasion, could be comprised in such limits as those of this Report; and the general nature of the more important results of his researches is already so well known, and so incorporated with the intellectual history of the last half century, that it constitutes a portion of the knowledge of every well-informed man. During the long period of fifty-five years, from the date of his first considerable mathematical production on the integration of equations of differences, in the *Turin Memoirs*, in 1772, to almost the moment of his death, his march was in the van of intellect; and the highest point of scientific attainment to which the age had reached, was uniformly marked by his progress.

His whole career was a succession of brilliant and profound discoveries, where every great step in the theoretical departments of analytical science was sure to be attended with a corresponding advance in its practical application; and every difficulty which occurred in applying his principles to the sublime problems of physical astronomy, served only to give rise to new methods, and create more powerful engines of mathematical inquiry; a rare combination,—of which Archimedes and Newton had afforded the only previous examples,—of a philosophical spirit of the first rank wielding all those unbounded resources of abstract science, which a few extraordinary men of a different turn may have perhaps possessed in an equal or superior degree, but which only attain their highest value when exerted from the vantage-ground of a mind at home in every department of experimental philosophy, impressed with the fullest sense of the importance of practical application, and familiar with all the means of disentangling principles from natural phenomena. Laplace also afforded a conspicuous instance of that union of gentle and amiable social qualities, which is one of the best characteristics of the highest order of genius — as indicating a mind secure of its rank. No pretension — no assumption — nothing dictatorial in science, or offensive in taste, marked his mild and modest deportment. They who have heard his sublimest views propounded with the diffidence of a youth seeking information; they whose early scientific attempts have been encouraged, and whose maturer efforts were assisted and directed by his talents, — will long retain a penetrating sense of this estimable feature of his character.

The only one of the prize questions proposed at the instance of the Council in February 1824, the period of which remained unexpired during the year elapsed, is that relating to the developement of the differential equations of the lunar theory, and the improvement of the lunar tables. No answer has been received to this question; and the proposed period has now expired. The Council have not thought it advisable either to prolong this period, or to propose any new questions for the present or future years: but, should subsequent researches either afford complete solutions of any of those questions, or material elucidations of their peculiar difficulties, future Councils will not fail to bear in mind the importance that attached to their subjects in the minds of former ones, and recommend to the Society the accordance of such marks of their approbation as the degree of progress made in them may appear to demand.

Two medals have been awarded this year by the Council. One to Sir Thomas Macdougal Brisbane, for the inestimable benefit conferred by him on astronomical science, in the establishment of his observatory at Paramatta in New South Wales, and for the valuable and important series of observations made there by himself, and under his directions, during his residence as governor of that colony. The other to Mr. James Dunlop, for his disinterested and indefatigable pursuit of astronomical researches, subsequent to the departure of Sir T. M. Brisbane from the colony of New South Wales, whereby he has added, in a most material degree, to our knowledge of the nebulæ of the southern hemisphere.

These medals will be delivered to these gentlemen respectively, or to their proxies, by the President, before the Society proceed to the business of election of the officers for the ensuing year.

By the fifth section of the regulations of the Society, every member is called upon to pay down four guineas at the time of his election, which appears not strictly equitable in those cases where members have been elected immediately preceding the anniversary in any year, when the annual contribution *again* becomes due. In order to meet this subject fairly, and with a due regard both to the interests of the new members and of the Society, it has been agreed by the Council, that it would be proper to divide the year into two parts: one commencing with the anniversary, and terminating with the session in June; and the other commencing from June, and ending with the next anniversary. The Council are of opinion, that those who are admitted in the latter part of the year should pay only three guineas on their election, whilst the regulation will remain in full force with respect to those who are elected in the first part of the year.

They are of opinion also, that a similar distribution should be made of the year in which any non-resident member may first become a resident member.

It has further appeared expedient to the Council, to propose an addition to one of the regulations relative to members who may be in arrears to the Society.

Regulations, which in the judgment of the Council will provide for these several cases, will be submitted to your consideration during the present meeting.*

The Council cannot conclude this Report without an earnest exhortation to the members of the Society, collectively and individually, to co-operate by their active exertions in the great cause for which the Institution exists. They entreat them to remember, that every one who possesses an instrument, whose claims rise even not above a humble mediocrity, has it in his power to chalk out for himself a useful and honourable line of occupation for leisure hours, in which his labour shall be really valuable, if duly registered: that those who possess *good* instruments, have a field absolutely boundless for their exertions. To such they would hold out the brilliant examples of many other of the members and associates of this Society,—of a Bessel, a Struve,—as shewing what may be accomplished by persevering industry, and how little reason there is to apprehend the failure of matter for their researches. They would strongly impress on the minds of all observers, however, whether private or public, the daily increasing necessity which exists for the *reduction* of their observations when made, and for the employment for that purpose of a uniform system of corrections adopted by common consent; and that, not when the work of many years shall have accumulated on hand till it shall have become overwhelming, but regularly, year by year—nay, month by month, while the immediate interest of the observations retains its freshness in the memory, and while their actual value can be checked, and the means of further refinement

* [The Regulations alluded to were adopted unanimously.—Sec.]

suggested and attained. The extreme facility afforded for these reductions by the Catalogue published by this Society, leaves no excuse for their neglect, when stars contained in it are observed; and it is most earnestly to be hoped, that no departure in other cases, from the co-efficients there used, will take place.

The Council would also strongly draw the attention of the members of the Society to the high importance, both for nautical and astronomical science, of observations of occultations, eclipses of the sun, and satellites of Jupiter, moon-culminating stars, and even ordinary lunar distances well and carefully observed on land, at fixed stations, such as observatories, and at all remarkable points in distant countries, where opportunities may offer. The Society will feel its utility most materially increased by the communication of such observations, if carefully made. No class of individuals have so frequent and available opportunities for such observations as naval officers, nor to any is the object of such direct utility. It is gratifying to know, that the requisite scientific attainments for such researches are already widely diffused among them, and daily becoming more so; and it is cheering to indulge the pleasing reflection, that the calls thus made upon them will not be unavailing.

(*The President then addressed the meeting on the subject of the award of the Medals, as follows:—*)

Gentlemen,—In pursuance of the award of your Council, which you have just heard, I have now to call your attention to the subject of the honorary marks of this Society's approbation, which it is part of our business at this meeting to bestow. The selection of objects on which such distinction may most deservingly and most usefully be conferred, has been, in this instance, of much interest and some difficulty,—not from a paucity of claims, but from their variety and magnitude. On all sides, both abroad and at home, the spirit of astronomical research and discovery has been diligently alive. The great work which has been commenced on the Continent, for the determination of the places of all the stars of our hemisphere in zones, has been continued with a patient ardour to which no words can do justice. The heavens have been ransacked for double stars; and the results of the search, developing a most rich and unlooked-for harvest of striking discoveries, being the first fruits of the great telescope of Fraunhofer, have been consigned to immortality, in a work which does honour to its age and nation, and which has already been brilliantly rewarded in another quarter. The ingenuity of one of our own countrymen has placed new, simple, and powerful means in the hands of observers, for verifying the stability of their instruments, and determining their fluctuations. And in every quarter, to go no further in this detail, an activity, worthy of the high ends and dignity of our science, has been remarkably displayed. Among so many important labours, however, some of which are yet awaiting their final completion, or receiving the last touches of their authors, the attention of your Council has been fixed by the imposing mass of valuable observations which has emanated, during a series of years, from the Observatory at Paramatta, established by the late governor

of the colony of New South Wales, Sir Thomas Macdougal Brisbane, one of our Vice-Presidents, long distinguished among us by his ardent love of astronomy, and an intimate familiarity both with its theory and practice.

Nothing can be more interesting in the eyes of an European astronomer, especially to those whose field of research, like our own, is limited by a considerable northern latitude,—than the southern hemisphere, where a new heaven, as well as a new earth, is offered to his speculations; and where the distance, the novelty, and the grandeur of the scenes thus laid open to human inquiry, lend a character almost romantic to their pursuit.

A celestial surface, equal to a fourth part of the whole area of the heavens, which is here for ever concealed from our sight, or whose extreme borders at least, if visible, are only feebly seen through the smoky vapours of our horizon,—affords to our antipodes the splendid prospect of constellations different from ours, and excelling them in brilliancy and richness. The vivid beauty of the Southern Cross has been sung by poets, and celebrated by the pen of the most accomplished of civilised travellers; and the shadowy lustre of the Magellanic clouds has supplied imagery for the dim and doubtful mythology of the most barbarous nations upon earth. But it is the task of the astronomer to open up these treasures of the southern sky, and display to mankind their secret and intimate relations. Apart, however, from speculative considerations, a perfect knowledge of the astronomy of the southern hemisphere is becoming daily an object of greater practical interest, now that civilisation and intercourse are rapidly spreading through those distant regions,—that our own colonies are rising into importance,—and that the vast countries of South America are gradually assuming a station in the list of nations, corresponding with their extent and natural advantages. It is no longer possible to remain content with the limited and inaccurate knowledge we have hitherto possessed of southern stars, now that we have a new geography to create, and latitudes and longitudes without end, to determine by their aid. The advantages, too, to be obtained, even for the perfect and refined astronomy of the north, by placing nearly a diameter of the globe between the stations of observatories, and taking up the objects common to both hemispheres, in a point of view, and under circumstances so every way opposite to those which exist here, have been strongly pointed out by a venerable and illustrious member of this Society, in an elaborate paper published in its Memoirs, and would alone suffice to justify a high degree of interest, as due to every well-conducted series of observations from that quarter. The observations of Halley, at St. Helena, had made known the places of a moderate number of the brighter southern stars; but the only catalogue of any extent and accuracy, which existed previous to the establishment of the observatories of the Cape and Paramatta, was that of Lacaille, who spent three years at the Cape of Good Hope, and the Isles of France and Bourbon; and, though with very inadequate instrumental means, yet, by dint of the most indefatigable industry, succeeded in observing and registering upwards of 10,000 stars. But by far the greater part of these observations

have never been reduced; a selection only from them of 1942 of the principal ones, not amounting to a fifth of their whole number, having been formed into a catalogue, and published by this meritorious astronomer. It must be admitted, however, that the degree of accuracy stated by Lacaille himself to have been probably attained by him, is hardly such as to make us now very deeply regret their want of reduction, especially as the observations themselves are printed with every requisite for that purpose, when required. Still, however, from his method of observing, which was with a fixed telescope and rhomboidal network, his observations have what may be termed a dormant value, as they most probably give correct differences for each night's work; and when a catalogue of standard southern stars shall be completed, Lacaille's observations will become available, by regarding these as zero points, and referring all the rest to them.

Such was nearly, with little improvement, the state of the astronomy of the southern hemisphere, when Sir Thomas Brisbane was appointed governor of the colony of New South Wales. The intention of our Government to found an observatory on the largest scale at the Cape of Good Hope was, indeed, already fixed; and the observer, a member of this Society, supplied with instruments sufficient for the purpose of constructing a preliminary catalogue, occupied himself with the necessary observations, while awaiting the arrival of those ultimately destined to adorn that establishment, and the building of his observatory. The approximate catalogue, so constructed and reduced, containing all the southern stars observed by Lacaille, down to the 5th magnitude, is already printed by the Royal Society, in their Transactions.

Sir Thomas Brisbane's attachment to astronomy had ever been a prevailing principle of his mind, and one which, even amidst the distractions of a military life of no ordinary degree of activity and adventure, he found means to indulge; and which never deserted him, however the calls of his country might demand his services in a different and more splendid career.

His appointment to the important office of governor of New South Wales, however, put it in his power to execute to their fullest extent, and under the most favourable circumstances, plans of astronomical investigation, which to a private individual would have been utterly impracticable. The opportunity was embraced with eagerness. The best instruments,—consisting of an excellent transit of 5½ feet focal length, by Troughton; a mural circle of two feet in diameter, the workmanship also of Troughton, and said to have been the model on which that of Greenwich was constructed, and which had long been in his possession; and a fine 16-inch repeating circle of Reichenbach, —were destined for this service; and two gentlemen engaged as assistants, at considerable salaries,—the one a foreigner of high estimation as a mathematician and calculator; the other, Mr. Dunlop, of whom I shall presently have occasion to say much more. It ought to be mentioned, that this noble equipage was furnished entirely from Sir Thomas's private fortune, and maintained wholly at his own expense. Immediately on his arrival in the colony in 1821, and so

soon as an observatory could be erected, and the instruments established, the work of observation commenced, and continued, with little interruption, under the immediate superintendence and direction of Sir Thomas Brisbane himself; who, though the pressing and important duties of his high office would of necessity seldom admit of his devoting any material proportion of his time to actual observation, yet frequently took a personal share in the labours of the observatory, as a relaxation from higher duties, and in particular, a great portion of the transits were observed by himself.

The first fruits of this enterprise, were the observations of the December solstice of 1821, which were published in the Astronomical Notices of Schumacher; in which work also appear those of both the solstices of 1822, and a number of detached and occasional observations, which reached Europe at different times by a variety of channels, and found their way into that valuable collection. The solstices of 1823 were communicated by Sir Thomas Brisbane to this Society, in a letter to our late worthy president, together with a considerably extensive series of observations of principal stars, chiefly those visible in both hemispheres, and which have undergone a careful reduction and close scrutiny in the hands of Dr. Brinkley, the details of which, as well as the original observations, are printed in the first part of the second volume of the Transactions of this Society, and which justify, in the eyes of that experienced observer, as they must in those of every practical astronomer, a decided opinion of the great care and skill with which they have been made.

A great number of occasional observations,—such as eclipses, occultations, and observations of the planets Venus and Uranus, near their conjunctions and oppositions, and of comets from the same source,—are also printed in the same volume. One of the most remarkable single results we owe to the establishment of Sir Thomas Brisbane's observatory, consists in the re-discovery of the comet of Encke, in its predicted place, on the 2d June, 1822. The history of this extraordinary body is well known to all who hear me; and as its re-discovery at Paramatta by Mr. Rümker has already been, on a former occasion, distinctly noticed and rewarded by this Society, there is no occasion that I should here enlarge on it; and yet I cannot help pausing a moment to figure the delight its celebrated discoverer must have experienced, to find the calculations, on whose exactness he had pledged himself, thus verified beyond the gaze of European eyes; and this strange visitant gliding, as if anxious to elude pursuit, into its primitive obscurity, thus arrested on the very eve of its escape, and held up to mankind,—a trophy at once of the certainty of our theories, and the progress of our civilisation.

Observations of the length of the pendulum were not neglected by Sir Thomas Brisbane; and the determination of this important element at Paramatta forms the subject of a highly interesting and valuable communication made by him to the Royal Society, and printed by them in their Transactions for 1823, and discussed by Captain Kater with his usual care and exactness.

The remainder, and indeed the great mass, of the observations made with the mural circle and the transit instrument have, at

different periods, been communicated to the Royal Society, and are for the present deposited in its archives. Forming our judgment only upon those of which an account has been publicly read at the meetings of that illustrious body, but which are understood to constitute only a comparatively small part of the whole,—they form one of the most interesting and important series which has ever been made, and must ever be regarded as marking a decided era in the history of southern astronomy.

It is for this long catalogue of observations—whether scattered through the journals of Europe, printed in our own Transactions, or deposited as a precious charge in the care of a body so capable of appreciating their merits; but still more for the noble and disinterested example set by him in the establishment of an observatory on such a scale, in so distant a station, and which would have equally merited the present notice had every observation perished in its conveyance home—that your Council have thought Sir Thomas Macdougal Brisbane deserving the distinction of a medal of this Society, which, as he is unable personally to attend this meeting, I will now deliver to his proxy, Mr. South.

Mr. SOUTH,—We request you to transmit to Sir Thomas Brisbane this medal, accompanied with the strongest expressions of our admiration of the patriotic and princely support he has given to astronomy, in regions so remote. It will be a source of honest pride to him while he lives, to reflect that the first brilliant trait of Australian history marks the era of his government, and that his name will be identified with the future glories of that colony, in ages yet to come, as the founder of her science. It is a distinction truly worthy of a British governor. The colonial acquisitions of other countries have been but too frequently wrested from unoffending inhabitants, and the first pages of their history blackened by ferocious conquests and tyrannical violence. The treasures of gold and silver they have yielded—the fruits of rapine—have proved the bane of those who gathered them, and, in return, ignorance and bigotry have been the boons bestowed on them by their parent nations. Here, however, is a brighter prospect. Our first triumphs in those fair climes have been the peaceful ones of science; and the treasures they have transmitted to us are imperishable records of useful knowledge, speedily to be returned with interest, to the improvement of their condition and their elevation in the scale of nations.

(*The President then resumed his address to the Members, as follows:*—)

I have now to call your attention, gentlemen, to the award of another medal, to Mr. Dunlop, who accompanied Sir Thomas Brisbane in capacity of his assistant, and who, since the middle of the year 1823, when his companion, Mr. Rümker, left the observatory, remained in the sole charge of the instruments; and up to the period of the departure of his principal from the colony, continued an uninterrupted series of observations with a care and diligence seldom equalled, and never surpassed. In such cases, it is not only the head which plans, but the hand which faithfully and promptly executes,

that claims our applause. The most liberal provision of instrumental means would have been comparatively unavailing, had the spirit of him who supplied them been seconded by any ordinary zeal on the part of his assistants. The records of this Society already alluded to bear sufficient testimony to the merits of Mr. Rümker, and to our sense of them. In Mr. Dunlop were combined qualities rendering him of all others the very individual fitted for the duties imposed on him—zealous, active, ready—but, above all (and the combination is not an ordinary one), industrious and methodical. In the vast mass of observations made and registered by him, all is equable and smooth, as if the observations had all been made at a sitting:

"..... Servatur ad imum
Qualis ab incepto processerit"—

no lacunæ, no long intervals of inactivity, nothing hurried or sketchy,—but the same pains-taking, laborious filling in, pervading the whole; marking that the observer's whole heart and soul were in his work, and that each individual observation possessed its own peculiar, though momentary, interest. Nor is this wonderful. The heavens visible to Europeans have been so thoroughly examined, and their contents so carefully registered, that there is not the slightest rational probability of any thing new or uncommon offering itself to instruments of moderate power in the ordinary course of observation. Here, however, all was new; for the optical power of Lacaille's telescope was far too feeble to afford much insight into the physical constitution of the objects determined with it: and thus all the excitement of discovery was maintained during every step in the progress of the work.

But to be susceptible of this excitement, so maintained, the observer must be animated by the true spirit of the astronomer; and few have possessed this spirit in a greater degree than Mr. Dunlop. In a scientific point of view, therefore, he must be regarded as the associate, rather than the assistant, of his employer; and their difference of situation becomes merged in their unity of sentiment and object. These considerations alone would have rendered it impossible to your Council to disunite, in any expression or mark of their approbation, individuals who have thus, each in his sphere, gone hand in hand together towards the perfection of Southern Astronomy, even had the labours of Mr. Dunlop been confined to the ordinary business of an observatory, or to observations with fixed instruments. But this is very far from having been the case. The nebulous, as well as the sidereal heavens, have occupied his attention; and in the prosecution of this most delicate and difficult branch of astronomy, he has availed himself entirely of his own resources, in the most literal sense,—the instrument which he used being not simply his *own*, but the work of his own hands; and the observations being performed by him after the departure of Sir Thomas Brisbane from the colony, at a personal sacrifice of his private interests, and in the face of difficulties which would have deterred any one not animated with a real and disinterested love of science, from their prosecution. The results of these observations have been the description and determination of the places of upwards of 600 nebulæ

and clusters of stars. And when it is recollected that Lacaille was able to observe not more than about 40 or 50 of these curious objects, we may form some idea of the extent of this labour. In addition to these interesting results, Mr. Dunlop has amassed a copious and valuable collection of Southern double stars, which he is at present occupied in reducing and arranging; and a variety of interesting and curious particulars relative to the magnitudes, colours, and other peculiarities, of all the more conspicuous single ones.

Shut out as we are by our geographical situation from the actual contemplation of these wonders, the astronomers of Europe may view, with something approaching to envy, the lot of these their more fortunate brethren. The feeling, if an unworthy, is, however, but a passing one, and merges in that of admiration of their zeal and enterprise, and of gratitude for the information they have afforded us. In testimony of that admiration and that gratitude, on the part of this Society, towards Mr. Dunlop, I beg of you, Mr. South, to transmit to *him* also, this our medal, and to accompany it with the assurance, that wheresoever his future fortunes may lead him — whether in the land which has already witnessed his meritorious labours, to complete and extend them; or in his native country, which is both able and willing to appreciate his value, to put the finishing stroke to the noble fabric he has been mainly instrumental in raising, by taking a leading part in the less exciting, but not less useful or indispensable work, of reducing the observations already made — in either case, he will be attended by our best wishes for his prosperity and happiness, and our confidence that science will continue to benefit by his exertions.

(*The President having quitted the chair, was succeeded by* Mr. South, *one of the Vice-Presidents, who addressed the Meeting as follows*:—)

Gentlemen,—Our excellent President, in his address, has informed you of the appropriation of two of your gold medals since our last Anniversary: a third, however, has been decreed by your Council; and when it is known that Miss Caroline Herschel is the individual to whom it stands adjudged, it is not difficult to determine why the President has avoided the slightest allusion to it.

But that your Council has not selected one from the many of its members, infinitely more competent to do justice to the transcendent merits of that illustrious lady, is, most assuredly, matter of regret. I must, therefore, throw myself upon your indulgence, hoping that the goodness of the cause may in some measure compensate for the inability of its advocate.

The labours of Miss Herschel are so intimately connected with, and are generally so dependent upon, those of her illustrious brother, that an investigation of the latter is absolutely necessary ere we can form the most remote idea of the extent of the former: but when it is considered that Sir W. Herschel's contributions to astronomical science occupy sixty-seven Memoirs, communicated from time to time to the Royal Society, and embrace a period of forty years, it will not be expected that I should enter into their discussion. To

the Philosophical Transactions I must refer you, and shall content myself with the hasty mention of some of her more immediate claims to the distinction now conferred. To deliver an eulogy (however deserved) upon *his* memory is not the purpose for which I am placed here.

His first catalogue of new nebulæ and clusters of stars, amounting in number to one thousand, was made from observations with the 20-feet reflector, in the years 1783, -4, and -5. A second thousand were furnished by means of the same instrument in 1785, -6, -7, and -8; whilst the places of five hundred others were discovered between 1788 and 1802. But when we have thus enumerated the results obtained in the course of *sweeps* with this instrument, and taken into consideration the extent and variety of the other observations, which were at the same time in progress, a most important part yet remains untold. Who participated in his toils? Who braved with him the inclemency of the weather? Who shared his privations?—A female! Who was she?—His sister! Miss Herschel it was who by *night* acted as his amanuensis! She it was whose pen conveyed to paper his observations as they issued from his lips; she it was who noted the right ascensions and polar distances of the objects observed; she it was who, having passed the night near the instruments, took the rough manuscripts to her cottage at the dawn of day, and produced a fair copy of the night's work on the subsequent morning; she it was who planned the labour of each succeeding night; she it was who reduced every observation, and made every calculation; she it was who arranged every thing in systematic order; and she it was who helped him to obtain an imperishable name.

But her claims to our gratitude end not here. As an original observer she demands, and I am sure she has, our most unfeigned thanks. Occasionally, her immediate attendance during the observation could be dispensed with. Did she pass the night in repose? No such thing: wherever her illustrious brother was, there you were sure to find her also. A sweeper planted on the lawn became her object of amusement; but her amusements were of the higher order, and to them we stand indebted for the discovery of the comet of 1786, of the comet of 1788, of the comet of 1791, of the comet of 1793, and of the comet of 1795, since rendered familiar to us by the remarkable discovery of Encke. Many also of the nebulæ contained in Sir W. Herschel's catalogues were detected by her during these hours of enjoyment. Indeed, in looking at the joint labours of these extraordinary personages, we scarcely know whether most to admire the intellectual power of the brother, or the unconquerable industry of the sister.

In the year 1797, she presented to the Royal Society a catalogue of 560 stars, taken from Flamsteed's observations, and not inserted in the British Catalogue; together with a collection of errata that should be noticed in the same volume.

Shortly after the death of her brother, Miss Herschel returned to Hanover. Unwilling, however, to relinquish her astronomical labours whilst any thing useful presented itself, she undertook, and completed, the laborious reduction of the places of 2500 nebulæ, to the 1st Jan. 1800, presenting in one view the results of all Sir

William Herschel's observations on those bodies; thus bringing to a close half a century spent in astronomical labour.

For this more immediately, and to mark their estimation of services rendered during a whole life to astronomy, your Council resolved to confer on her the distinction of a medal of this Society. The peculiarity of our President's situation, however, and the earnest manner in which the feelings, naturally arising from it, were urged when the subject was first brought forward, caused your Council to pause, and wave, on that occasion, the actual passing their proposed vote. The discussion was, however, renewed on Monday last; and although there was every disposition to meet the President's wishes, still, under a conviction that the doing so would have been a dereliction of public duty, it was

Resolved unanimously, "That a Gold Medal of this Society be given to Miss Caroline Herschel, for her recent reduction, to January 1800, of the Nebulæ discovered by her illustrious brother, which may be considered as the completion of a series of exertions, probably unparalleled, either in magnitude or importance, in the annals of astronomical labour." A vote which I am sure every one whom I have the honour to address will most heartily confirm.

Mr. HERSCHEL,—In the name of the Astronomical Society of London, I present this Medal to your illustrious Aunt. In transmitting it to her, assure her, that since the foundation of this Society, no one has been adjudged which has been earned by services such as hers. Convey to her our unfeigned regret that she is not resident amongst us; and join to it our wishes, nay, our prayers, that as her former days have been glorious, so her future may be happy.*

List of Officers for the ensuing year.

President: J. F. W. Herschel, Esq. M.A. V.P.R.S. L. & E. F.G.S. & M.R.I.A.—*Vice-Presidents:* Francis Baily, Esq. F.R.S. L.S. & G.S. & M.R.I.A.; Lieut.-Gen. Sir T. M. Brisbane, K.C.B. F.R.S. L. & E.; Davies Gilbert, Esq. M.P. *Pres.* R.S. F.L.S. & G.S.; James South, Esq. F.R.S. L. & E. F.L.S. & M.R.I A.—*Treasurer:* Rev. William Pearson, LL.D. & F.R.S.—*Secretaries:* Olinthus G. Gregory, LL.D. *Prof. Math. Roy. Mil. Acad. Woolwich*; Lieutenant William S. Stratford, R.N.—*Foreign Secretary:* Charles Babbage, Esq. M.A. F.R.S. L. & E. & M.R.I.A.—*Council:* Capt. F. Beaufort, R.N. F.R.S.; Henry Thomas Colebrooke, Esq. F.R.S. L. & E. F.L.S. & G.S.; Lieut.-Col. Thomas Colby, R.E. LL.D. & F.R.S. L. & E.; Benjamin Gompertz, Esq. F.R.S.; Rev. Dionysius Lardner, M.A. & M.R.I.A.; Rear Adm. Sir Edw. C. R. Owen, K.C.B.; Edw. Riddle, Esq.; Rev. Rich. Sheepshanks, M.A.; Capt. W. H. Smyth, R.N. F.R.S. &. A.S.; Edward Troughton, Esq. F.R S. L. &. E.

* He who has the honour to deliver this hasty address, feels no slight gratification in having been present, on the 1st of June, 1821, at the last observations, with the 20-feet reflector, in which Miss Herschel was engaged. He remembers also, not without regret, but with becoming gratitude, that, for his improvement, the mirror used on the occasion was inserted, for the last time, in the tube, by the hands of Sir W. Herschel.

J. Moyes, Castle Street, Leicester Square.

ASTRONOMICAL SOCIETY OF LONDON.

March 14, 1828. No. 10.

The first paper read this evening was the following:—Ephemeris of the place of Encke's Comet, during the time of its re-appearance at the end of the present year. Drawn up at the request of the Council of the Society. By F. Baily, Esq.

1828.	AR	Dec.	1828.	AR	Dec.
	h m s	° ′		h m s	° ′
Aug. 23	1 47 24	+22 43	Nov. 15	21 58 4	+18 25
27	1 47 8	23 20	17	21 49 36	17 20
31	1 46 12	23 57	19	21 41 20	16 13
Sept. 4	1 44 40	24 34	21	21 33 16	15 5
8	1 42 16	25 11	23	21 25 20	13 57
12	1 39 0	25 48	25	21 17 36	12 48
16	1 35 44	26 24	27	21 9 56	11 38
20	1 29 20	26 58	29	21 2 20	10 27
24	1 22 36	27 30	Dec. 1	20 54 44	9 14
28	1 14 28	27 59	3	20 47 4	8 1
30	1 9 48	28 12	5	20 39 20	6 45
Oct. 2	1 4 48	28 23	7	20 31 20	5 27
4	0 59 16	28 32	9	20 23 12	4 7
6	0 53 24	28 40	11	20 14 40	2 42
8	0 47 4	28 45	13	20 5 48	+ 1 14
10	0 40 16	28 47	15	19 56 28	− 0 20
12	0 33 4	28 47	17	19 46 40	1 58
14	0 25 24	28 43	19	19 36 20	3 42
16	0 17 24	28 36	21	19 25 32	5 32
18	0 9 0	28 25	23	19 14 20	7 28
20	0 0 16	28 9	25	19 2 48	9 28
22	23 51 12	27 50	27	18 51 16	11 31
24	23 41 52	27 25	29	18 40 0	13 35
26	23 32 24	26 56	31	18 29 28	15 38
28	23 22 44	26 23	1829.		
30	23 13 0	25 44	Jan. 10	18 4 24	24 14
Nov. 1	23 3 12	25 1	13	18 10 16	25 50
3	22 53 28	24 14	16	18 20 12	26 57
5	22 43 48	23 23	19	18 31 4	27 43
7	22 34 16	22 29	21	18 39 20	28 4
9	22 24 52	21 32	26	19 0 40	28 24
11	22 15 44	20 31	31	19 21 4	28 19
13	22 6 48	+19 29	Feb. 9	19 53 52	−27 34

The first part of the above ephemeris (to the end of the year 1828) is taken from Mr. Encke's own computations for Paris time $0^d.3$, as inserted in Professor Schumacher's *Astronomische Nachrichten*, No. 123. That part of it which belongs to the ensuing year, 1829, is taken from a letter addressed to the President of this Society by Dr. Olbers, and is computed for the time of midnight at Paris. The positions are computed for every third or fourth day only, at the beginning and end of the ephemeris, and for every second day towards the middle: this being quite sufficient to enable the observer to find the place of the comet in the heavens. The original computations are extended only to minutes of space; but the right ascensions are here converted into the nearest second of time, for the convenience of the observer.

[It being desirable that as many observations should be made of this comet as possible, particularly in the southern hemisphere, where it will probably be seen after its return from the sun, an extra number of copies of the above ephemeris have been struck off for distribution, not only amongst the Members of the Society, but also for circulation in various parts of the world where the comet is likely to be seen. And Capt. Foster has kindly undertaken to distribute them as much as possible in those parts of the southern hemisphere at which he may touch during the scientific voyage in which he is about to embark.]

There was next read a paper, "On finding the rates of time-keepers;" by E. Riddle, Esq. In this communication the author observes, that there are many persons fond of astronomy who are not possessed of a transit instrument, or who have not a convenient situation in which to place it; and many others, such as nautical men in particular, who have not the means of using one, who are desirous, on many accounts, of knowing the *rates* of their chronometers, independent of the absolute time which they indicate. The method of equal altitudes on *each side* of the meridian is the course usually pursued on such occasions; but Mr. Riddle proposes another mode, often much more convenient in practice and equally correct in its results; viz. by taking equal altitudes of a fixed star on the *same side* of the meridian, on successive nights. It is well known that a star will, at the same sidereal hour, arrive at the same altitude for several succeeding nights: the only difference which occurs arising from the small change in the aberration, and also from the variation in the refraction The former is insensible, if the interval between the observations be not too long; and for the latter, appropriate tables are given. The best time for the observation of such stars is when they are due east or due west; and any known star may be chosen for the purpose. All we have to do, therefore, is to note the difference of the two consecutive times at which the star attains the same altitude (whatever it be) on the same side of the meridian; and if that difference be *less* than $3^m\ 55^s,91$, the chronometer (presuming that it is regulated to mean solar time) will have *gained*; and if *more*, it will have *lost* so much in a sidereal day. And if the observations are made at an interval of n days, the *nth part of the* difference between the times of observation, compared

with $3^m\ 55^s{,}91$, will in like manner give the mean rate for that interval; and if this quantity be multiplied by 1,0027, it will give the rate for a mean solar day. The author concludes his paper with several practical examples of the method; and also with a formula for reducing a series of observations made on any one night, to the same altitude as shewn by a series made on any other night: whereby the whole become strictly comparable.

Lastly, there was read the following communication from the Rev. Thomas John Hussey to Francis Baily, Esq.

"In forming a correct catalogue of the stars situated between 15° N. and 15° S. declination, and extending from $13^h\ 56^m$ to $15^h\ 4^m$ R.A. from the catalogues of Piazzi and Bradley, and the observations of Lalande and Bessel, Mr. Dawson and myself have been much struck with the difference between the places of particular stars, as laid down by Piazzi and Bradley, and the places assigned by reducing the observations of M. Bessel. The results obtained from the *Histoire Céleste* come as nearly to the standard catalogue as can be expected, considering the nature of the instrument employed for determining the zenith distances, and thence the declination in which principally the differences exist: some few of these between observations of the same star are rather unaccountable, others may be attributed to errors of the press; they are as follow."—*Histoire Céleste.*

		h	m	s		°	′	″	
Page 154	R.	14	42	$\overline{44}.5$	ZD.	57	2	12	read 34^s
— 155	—	14	13	43	—	50	$\overline{2}$	36	— 12′
— 155	—	$\overline{14}$	59	38·5	—	50	30	16	— 13^h
— 155	—	14	32	52·4	—	$\overline{59}$	5	42	— 49°
— 156	—	14	37	47	—	$\overline{50}$	45	34	— 58°
— 167	—	15	2	36	—	38	$\overline{47}$	6	— 27′
— 289	—	14	44	$\overline{33}.5$	—	61	10	8	— 32^s?
— 291	—	14	52	7·3	—	46	$\overline{59}$	0	— 58′
— 340	—	14	45	$\overline{56}·5$	—	54	20	49	— 50^s
— 471	—	14	46	$\overline{18}$	—	39	5	22	— 8^s

Between the places shewn by the observations of Lalande and those of M. Bessel, even where there are more than one observation by each of these astronomers, there are differences more or less considerable in *almost* every instance; occasionally, however, there is a surprising coincidence. On this subject we may hereafter trouble you with some remarks, my present object being to point out the differences between the standard catalogue of M. Piazzi and a catalogue reduced to 1800 from the observations of M. Bessel, of the only stars comprised within the above limits, which have been observed more than once by M. Bessel, so as that the place of the star may be considered as pretty nearly ascertained by this indefatigable astronomer alone. Their number amounts to 31, and the results are *exhibited in the following* table. The differences are *expressed in space.*

ASTRONOMICAL SOCIETY OF LONDON.

April 11, 1828. No. 11.

A PAPER was read "On the construction of large Achromatic Telescopes." By A. Rogers, Esq.—In this paper the author describes a new construction of an Achromatic Telescope, the object of which is to render a small disc of flint glass available to perform the office of compensation to a much larger one of crown, and thus to render possible the construction of telescopes of much larger aperture than are now common, without hinderance from the difficulty at present experienced in procuring large discs of flint glass. It is well known that in the ordinary construction of an achromatic object-glass, in which a single crown lens is compensated by a single one of flint, the two lenses admit of being separated only by an interval too small to afford any material advantage in diminishing the diameter of the flint lens, by placing it in a narrower part of the cone of rays, the actual amount of their difference in point of dispersive power being such as to render the correction of the chromatic aberration impossible, when their mutual distance exceeds a certain limit.

This inconvenience Mr. Rogers proposes to obviate, and obtain the advantage in question, by employing as a correcting lens, not a single lens of flint, but a compound one consisting of a convex crown and concave flint, whose foci are such as to cause their combination to act as a plane glass on the mean refrangible rays. Then it is evident, that by reason of the greater dispersive power of flint than of crown glass, this will act as a concave on the violet, and as a convex on the red rays; and *that* the more powerfully, according as the lenses separately have greater powers or curvatures. If, then, such a compound lens be interposed between the object-glass of a telescope, supposed to be a single lens of plate or crown glass, and its focus, it will cause no alteration in the focus for mean rays, while it will lengthen the focus for violet, and shorten it for red rays. Now this is precisely what is wanted to produce an achromatic union of all the rays in the focus; and, as nothing in this construction limits the powers of the individuals composing the correcting lenses, they may therefore be applied any where that convenience may dictate; and thus, theoretically speaking, a disc of flint glass, however small, may be made to correct the colour of one of crown, however large.

But this construction possesses other and very remarkable advantages. For, first, when the correcting lens is approximately constructed on a calculation founded on its intended aperture, and on the refractive and dispersive indices of its materials, the final and complete destruction of colour may be effected, not by altering the lenses by grinding them anew, but by sliding the combination nearer

to, or further from, the object-glass, as occasion may require, along the tube of the telescope, by a screw motion, till the condition of achromaticity is satisfied in the best manner possible. And, secondly, the spherical aberration may in like manner be finally corrected by slightly separating the lenses of the correcting glass, whose surfaces should for this purpose be figured to curvatures previously determined by calculation, to admit of this mode of correction — a condition which the author finds to be always possible.

Mr. Rogers explains his construction by reference to a diagram, and states the rule for the determination of the foci of the lenses of the correcting glass in a formula, which may be thus interpreted. "The focal length of either lens of the correcting lens is to that of the object-glass, in a ratio compounded of the ratio of the square of the aperture of the correcting lens to that of the object-glass, and of the ratio of the difference of the dispersive indices of crown and flint glass, to the dispersive index of crown:" — for example, to correct the colour of a lens of crown or plate glass of nine inches aperture, and fourteen feet focal length (the dimensions of the celebrated telescope of Fraunhofer at Dorpat) by a disc of flint glass three inches in diameter, the focus of either lens of the correcting lens will require to be about nine inches. To correct it by a four inch disc will require a focus of about sixteen inches each.

The author then remarks, that it is not indispensable to make the correcting glass act as a plane lens. It is sufficient if it be so adjusted as to have a shorter focus for red rays than for violet. If, preserving this condition, it be made to act as a concave lens, the advantage procured by Mr. Barlow's construction of reducing the length of the telescope with the same focal power, is secured: and he considers, moreover, that by a proper adaptation of the distances, foci, &c. of the lenses, we might hope to combine with all these advantages that of the destruction of the secondary spectrum, and thus obtain a perfect telescope.

There was also read a portion of a paper "On the Occultation of ϑ Piscium observed in Blackman Street, in the month of February 1821. References to recorded observations of occultations in which peculiarities have been apparently seen, either at the moon's limb, or upon her disc; together with an inquiry how far certain hypotheses seem adequate to account for the phenomena. By James South, Esq."

J. Moyes, Castle Street, Leicester Square.

ASTRONOMICAL SOCIETY OF LONDON.

May 9, 1828. No. 12.

A PAPER was read, entitled "Approximate Places of Double Stars in the Southern Hemisphere, for 1827, as observed at Paramatta, N. S. Wales. By Mr. James Dunlop."

After the departure of Sir T. M. Brisbane from the colony of New South Wales, the author, finding himself in the possession of reflecting telescopes capable of adding considerably to our knowledge of the nebulæ and double stars of that portion, resolved to remain, for the purpose of making a general survey of the heavens, from the south pole to 30° of south declination. The dark nights, in the absence of the moon, were devoted to observations of the nebulæ, and the moonlight to those of double stars, of which however only a part could be subjected to exact micrometrical measurement. The apparatus employed for this purpose consisted of a 46-inch achromatic telescope, equatorially mounted, and furnished with two micrometers; — one a parallel line micrometer, the author's own workmanship; the other, a double image micrometer, on Amici's principle. Those which could not be micrometrically measured, had their positions and distances noted by estimation while passing the field of the 9-feet reflector, with which they were discovered in the sweeps for nebulæ, and their places are given as determined in the sweeps.

The author prefaces his catalogue with the details of the micrometrical measures of about 30 principal Southern double stars, the most remarkable of which are *α Crucis* and *α Centauri*, the former bearing a great resemblance, both in the magnitudes and the mutual distance of its individuals, to *Castor;* the latter being a star of the first magnitude, accompanied by one of the fourth, at about 20″ distance,— a remarkable combination, such as does not occur in our hemisphere.

A Catalogue of 254 double stars, arranged in order of right ascension, follows, in which the right ascension to seconds of time, and declination to the nearer minute of space,— the position, quadrant, distance, the differences of right ascension and declination when observed, and the magnitudes, are set down in separate columns. They comprise double stars of all classes and of every variety. One very remarkable is the star 1 k *Argus*, Æ $8^h\ 4^m$, declin. — 42° 7′, which consists of individuals of the sixth and eighth magnitudes, the large star being blue, and the small one dusky red. This affords almost the only instance known of a combination of two considerably bright stars differing decidedly in mag-

nitudes, where a marked excess of the less refrangible rays enters into the composition of the light of the smaller star, and of the more refrangible into that of the larger. Among the double stars is set down also one of the seventh magnitude, right ascension $1^h\ 19^m\ 43^s$, declin. $-33°\ 31'$, of that singular deep red purple colour, of which examples are not wanting in our own hemisphere.

An extract of a letter was read from Professor Harding, of Göttingen, to Dr. Tiarks, in which he alludes to a phenomenon which had recently been observed by several astronomers on the continent, relative to an inequality of the dark space between the body of Saturn and its ring. This appearance was first noticed by M. Schwabe, on December 21, 1827, and has since been confirmed by several persons to whom M. Harding had communicated the circumstance. It seems that the space on the eastern side of the planet appears larger than the space on the western side. M. Harding was at first inclined to treat the whole as an optical deception, till the fact was confirmed by others, when he was induced to attempt an explanation of the phenomenon. He endeavoured to account for it by the present position of Saturn; but the result of his calculation proved that that cause would not increase the space (in March) more than $\frac{1}{88}$; a quantity probably too small to become perceptible to the eye. He indeed imagined that the appearance might be caused by the shadow of the body, which at present falls much beyond the south-eastern part of the ring, and which might render it impossible to perceive the equality of the two spaces. But this, he says, is disproved by the observation of M. Schwabe who saw the same phenomenon on the 31st of December, three weeks before the opposition, when the shadow was on the western side, and could be but faintly discerned. M. Harding is unable to explain it as an optical deception, and yet cannot consider it in any other light at present. Actual measurement, he says, can alone decide the question. He has already written to M. Struve to take some measures with his powerful telescope, and he requests that this communication may, with the same view, be forwarded to Messrs. Herschel and South, who have the best means, in this country, of determining this singular phenomenon.

Mr. South then read a note, which he had annexed to the above communication, stating, that in compliance with M. Harding's wishes, Mr. Herschel and himself had directed their attention to Saturn, but that they did not detect any inequality in the two spaces above alluded to, by means of micrometers attached to his 5-feet equatorial. The mean of 35 measures, taken on April 26, April 29, and May 8, gave the preceding (or western) space $3''{\cdot}532$, and the following (or eastern) space $3''{\cdot}607$. At the same time he remarks, that the mean of 20 measures taken on April 26 (viz. 10 by Mr. Herschel and 10 by himself), gave the spaces precisely the same; each being $3''{\cdot}472$. Mr. Herschel's measures gave the preceding (or western) space $3''{\cdot}612$, and the following (or eastern) space $3''{\cdot}442$; whilst his own gave the former $3''{\cdot}331$, and the lat-

ter 3″·502. Mr. South adds, however, that Mr. Herschel, after a careful examination, thought that, beyond all doubt, the following (or eastern) space appeared the larger: and it is a remarkable fact, that of seven persons who were present in Mr. South's observatory shortly afterwards, and who successively viewed Saturn through his 5-feet equatorial, six of them gave it as their opinion that the apparent right (or eastern) space was the larger: whilst the other observer declared he could not distinguish any difference. The situation, however, of Saturn was so low, as to render most of these observations far from satisfactory.

M. Harding also alludes in his letter to the re-appearance of the variable star in the constellation *Serpens*, mentioned in No. 5 of the Society's monthly notices. He says it is now again become visible, and has already attained the 8th or 9th magnitude. Its position for the beginning of this year is

$$R = 15^h\ 46^m\ 45^s \quad \text{Decl.} = +\ 15^\circ\ 39'\ 30'';$$

and he invites astronomers to watch this star during the period of its changes.

A communication was then read from Mr. Rumker, of the observatory at Paramatta, in New South Wales, giving an account of his observations for determining the absolute length of the pendulum vibrating seconds there, according to Borda's method. The apparatus with which these experiments were made, was constructed by Fortin, of Paris, and taken out to the colony by Sir Thomas Brisbane. There are some slight alterations from the apparatus described by M. Biot, which are pointed out by Mr. Rumker: and he also alludes to a new method of observing the coincidences. In Borda's method, the coincidence is determined by the intersection of the wire of the pendulum of experiment, with a cross marked on the bob of the pendulum of the clock. In lieu of this cross, Mr. Rumker placed a small graduated arc, and the determination of the coincidence resolves itself into observing the moment when the wire describes its minimum amplitude on the arc. Mr. Rumker likewise adopts a new mode of determining the correction for the arc of vibration. He finds that in large arcs (such as 8 or 9 degrees, to which his arcs sometimes extend,) the decrease is not in a geometrical progression, when the times are in arithmetical progression. He has therefore formed a table of the actual decrease of the arcs as observed by himself, at equal intervals of five minutes each, and given the corresponding corrections for each interval. In the course of his reductions he notices some errors in the formula given by M. Biot, for finding the centre of oscillation of a pendulum constructed according to the method of Borda. The mean of 41 series of experiments gives the length of the pendulum, vibrating seconds in Paramatta, *in vacuo*, at the freezing point, and at the level of the sea, equal to 992·412801 millimetres, or 39·071618 English inches.

J. Moyes, Castle Street, Leicester Square.

ASTRONOMICAL SOCIETY OF LONDON.

June 13, 1828. No. 13.

Professor Struve communicated the result of his observations and measurements of the apparent distance between the body and the ring of Saturn; from which it appears that he is decidedly of opinion that the body of Saturn is not in the centre of the ring. From a mean of 15 measurements, he makes the apparent distance on the left side equal to 11″·272, and on the right side equal to 11″·390: the difference is 0″·215. The probable error of these mean measurements he considers equal to 0″·024. M. Struve adds some slight corrections to his former measurements of the diameters, &c. of Jupiter, of Saturn, and of the Ring; which he has deduced from a more accurate determination of the value of his micrometer.

The next communication was from Mr. Prinsep, of Benares, giving an account of *two* eclipses which he had observed at that place in the course of the preceding year. The *first* was a solar eclipse on April 26, 1827. The commencement was not observed; but during the course of the eclipse a number of micrometrical measurements were taken by means of the five horizontal wires of a Troughton's 18-inch circle; and he states the end of the eclipse to have taken place at $20^h\ 3^m\ 7^s,5$ mean time at Benares. Mr. Prinsep then adds: "At the period marked as the end of the eclipse, the sun's disc was clear of the moon; but, for 10 or 15 seconds later, I remarked, as it were, a stretching of the sun's edge toward the point which the moon had just quitted. This was apparently the effect of refraction by the moon's atmosphere." The end of the eclipse was also observed by Mr. Walter Ewer at Cawnpore, at $19^h\ 56^m\ 3^s,5$ mean time at that place. The *second* eclipse, alluded to by Mr. Prinsep, was of the Moon, on November 3, 1827. It was observed in the same manner as the solar eclipse above mentioned. The following is the result of his observations, stated in mean time:

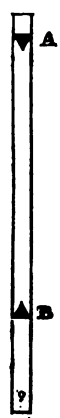
	h	m	s
The edge became dull at	8	42	0
The edge invisible.....	8	44	18
The edge of the same colour as the sky	8	45	30
Decided shadow	8	46	1
A bright spot becomes invisible	8	52	26
Immersion of a small star.....	10	42	14,2
Moon's transit ..... 1st limb	11	45	48,2
Do. do. ..... 2d limb	11	47	57,1
End of the eclipse.....	12	1	6

Mr. Walter Ewer observed the beginning of this eclipse at Cawnpore, $8^h\ 35^m\ 23^s$ mean solar time at that place: the difference of longitude is assumed equal to $-\ 10^m\ 12^s$. Diagrams illustrating the several phases of the eclipse, and apparently drawn up with considerable care, accompanied these communications.

Mr. Rumker, of Paramatta, in New South Wales, communicated the result of several series of observations in which he had been engaged at the observatory there. They contained, 1st, The determination of the solstice in December 1826, June 1827, and December 1827. In deducing the results, he notices the insufficiency of Delambre's formula for the *reduction to the meridian* in cases of great altitude; and suggests an alteration when the sun culminates near the zenith. 2nd, Observations on the inferior conjunction of Venus in December 1826. 3d, Observations of moon-culminating stars during parts of the years 1826 and 1827. 4th, Places of some of the fixed stars in the southern hemisphere. 5th, A catalogue of stars with which the great comet of 1825 was compared. 6th, Corrected observations of the place of the said comet. 7th, A determination of the latitude of the observatory by reflection with the mural circle.

The next communication was from Mr. Curnin, of Bombay, giving a more accurate account of his observations of moon-culminating stars at that observatory, during the year 1825: from a mean of all which, compared with corresponding observations at Bushy Heath and at Greenwich, he deduces the longitude of the observatory equal to $4^h\ 51^m\ 9^s$ east from Greenwich.

Mr. Baily presented a short account of the two invariable pendulums, the one of iron and the other of copper, which he had caused to be made, agreeably to the order of the Council, and which are intrusted to the care of Captain Foster in his present voyage of experiment and observation, for the purpose of investigating the possible effects of the earth's magnetism in various geographical positions. The form and construction of these pendulums are somewhat different from those in general use; consisting merely of a plain, straight, uniform bar of metal; and, as he conceived that there is a considerable advantage in having each pendulum a *convertible* pendulum, he has placed *two* knife-edges on each bar. This property of convertibility, however, instead of being effected by a sliding or movable weight, is produced by filing away one of the ends of the pendulum, until the number of vibrations on the two knife-edges are equal. The mode of making a pendulum of this kind he then describes in the following manner: Take a plain straight bar of metal, two inches wide, half an inch thick (or $\frac{3}{8}$ths of an inch, if thought preferable), and *about* $62\frac{1}{2}$ inches long; at least it should not be shorter than this, prior to the first trial for the adjustment. At five inches from one end of the bar should be placed the apex of one of the knife-edges, which he calls A, and at the distance of 39·3 inches therefrom, should be placed the apex of the other knife-edge, which he calls B; each knife-edge being firmly and properly secured in the usual manner. The distance of 39·3 inches is chosen, because the intervals of the coincidences are in such case about 15 minutes; but if an interval of about 10 minutes should be preferred, the distance should be about 39·4 inches: and so in proportion.



In order to adjust a pendulum of this kind, it must be placed on the agate planes, and the number of vibrations determined in the usual manner, beginning, for the sake of regularity, with the knife-edge A; then inverting the pendulum, and determining the number of vibrations with the knife-edge B. In these preliminary experiments it is not necessary to extend the observations beyond one coincidence; neither is it requisite to apply any other correction than for the arc of vibration, and for the temperature of the room, since all the other sources of error will be common to the two positions of the pendulum, and therefore may be rejected in these first trials. If it should be found (as will in fact be the case) that the knife-edge B makes a *less* number of vibrations in a day than the knife-edge A, we must file away the bar at the end B, until the two knife-edges are perfectly synchronous. The amount to be taken away can be ascertained by experiment only; and as we approximate towards the truth we must be more cautious in using the file, and more accurate in making the observations. In this last step of the progress it is difficult in all cases to determine the exact quantity that has been filed away; and we may sometimes overdo it, so as to cause an inequality in the vibrations of an *opposite* kind, and thus render it necessary to *add* a small quantity to the end B. In order to meet this difficulty, Mr. Baily caused a small hole to be drilled at the end B, into which a screw was fitted; and by means of a small piece of sheet lead inserted underneath, the adjustment could be carried to any required degree of accuracy.

The principal advantages attending the placing of two knife-edges on one and the same bar, Mr. Baily states to be as follows: viz. 1st, That we are thereby possessed of two separate and independent pendulums, the results of which may be used separately or conjointly at pleasure; and each of which is a more complete check on the other than when formed of separate pieces of metal, that may probably be of different specific gravities, and of different expansive qualities. 2d, That the knife-edges, being once rendered synchronous, will always remain so, into whatever part of the world the pendulum may be carried, and thus enable us, if it should be required, to determine the length of the simple pendulum at any point of the globe at which it may be swung, by merely measuring the distances between the knife-edges. 3d, That we are thus furnished with the means of ascertaining whether the pendulum has sustained any accidental injury; since such a fact would be *immediately* discoverable from the inequality in the number of vibrations between the two knife-edges. And, even in case of such an unforeseen misfortune occurring, the *ratio* between the two would from that moment remain the same in all parts of the world, and answer the same useful purpose of *comparison* during the remainder of the voyage. Whereas, in the pendulum as usually constructed, the effect of such an injury (if not suspected) might be attributed to the errors of observation: and, indeed, the fact itself could not be ascertained until the return of the observer to some place where the pendulum had been previously swung; leaving, however, the precise time at

which the accident happened still undetermined, and not only the observations themselves, during some indefinite period, the subject of doubt and suspicion, but probably the whole series of no utility or avail.

Mr. Baily considers that there are also some advantages attending the *form* of this pendulum; for, being uniform in its dimensions, without any protuberant bob or projecting tail-piece, it is not so liable to accident as the ordinary pendulum, where those parts present opportunities for injury. It is also capable of being packed in a more convenient case, and thus rendered more easy of transportation, when required as a travelling instrument. But he states that if we view it in the light of an instrument intended for the observatory, as a means of determining the length of the simple pendulum, where both knife-edges are necessary for the solution of the problem, the advantages will be more apparent; for, in the construction of the pendulum here proposed, none of the parts slide over one another: there are no shifting weights, no movable screws: every thing is fixed and stationary, and consequently more peculiarly adapted for the determination of so nice and difficult a problem.

As these pendulums are formed without any tail-piece, it became necessary to adopt some other mode of determining the arc of vibration. This Mr. Baily has effected by making the edge of the pendulum, which is perfectly straight, answer the purpose of the point in the tail-piece of the ordinary pendulum: and by this method he was also enabled to enlarge the divisions of the scale (which is a diagonal one), so that the hundredth part of a degree occupies the length of three-tenths of an inch, and consequently can be read off with the greatest ease.

The reading of Mr. South's paper "On the Occultation of ϑ *Piscium* by the Moon, &c." commenced in April, was resumed and concluded.

Of all the phenomena which occupy the attention of the practical astronomer, the author of this paper considers that no one admits of such accurate observation as does the occultation of a fixed star by the moon; occasionally, however, a circumstance presents itself to his notice, which merits peculiar consideration, namely, an apparent projection of the star upon the lunar disk; the instances in which this anomaly has been observed in this country, are indeed rare, and this, he says, led many to consider it the attendant of a lively imagination. If, however, we dispassionately review the observations of continental astronomers, of unsullied reputation, there will, Mr. South says, be little reason to doubt the fact of apparent projection, although perhaps there may be considerable difficulty in arriving at its cause.

The only instance in which Mr. South has witnessed the phenomenon, was previous to the occultation of ϑ *Piscium*, on the 6th of February, 1821. (Latitude of the observatory 51° 30′ 2″,97 north, longitude of the observatory 21ˢ,76 west.) The night was beautifully fine, the moon's dark limb and unilluminated disk unusually

distinct, the atmosphere peculiarly serene, and the moon's limb, as well as the star, remarkably steady. The observation was made with his five-feet equatorial, furnished with a power of 127; the observer was at the telescope four or five minutes before the immersion could happen: every thing went on as usual, till the moon's limb came in contact with the star, but the expected occultation did not occur. He noted the time when the apparent contact took place, which was at $3^h\ 20^m\ 54^s,0$ by the clock. The star, unshorn of any of its splendour, remained visible on the unillumined lunar disk till $3^h\ 21^m\ 2^s,9$ by the clock, when it instantaneously disappeared. Not the slightest sensible deviation in the star's place occurred between the moments of apparent contact and subsequent disappearance; and it exhibited the same perfectly defined disk whilst on the moon's limb, as it was observed to have previously to the contact.

The corrections for the clock's error being applied, the observations will stand thus:

	h	m	s
Apparent contact at	3	20	29,87
Instantaneous immersion	3	20	38,77
Emersion	4	14	32,88

The only corresponding observations of this occultation which have come to Mr. South's knowledge, were made by Mr. Littrow and Mr. Baily, and their results are given in the Memoirs of this Society. As Mr. Littrow has not narrated any peculiarity, it is probable none presented itself to him; and Mr. Baily has authorised Mr. South to state that he saw nothing anomalous; a circumstance certainly important, seeing that in Blackman Street the apparent projection of the star on the moon's disk continued nearly nine seconds of time. On the same evening, in Blackman Street, a star of the 8th or 9th magnitude suffered occultation by the moon's dark limb, nearly at the same part at which δ *Piscium* entered on the disk; the star disappeared instantaneously at $5^h\ 2^m\ 6^s,0$ by Mr. South's clock: prior to occultation, however, this star was not seen projected upon the limb; but the low altitude of the moon rendered the observation less satisfactory than was the previous occultation of δ *Piscium*.

The recorded observations of other astronomers are then quoted in the words of their respective authors, or in authentic abstracts, and are principally derived from the *Mémoires de l'Académie Royale des Sciences*, the *Histoire et Mémoires de l'Académie Royale des Sciences de Toulouse*, the *Histoire Céleste Française*, the *Connoissance des Tems*, and the *Observations Astronomiques faites à l'Observatoire Royal de Paris*, tom. i.: this done, they are arranged in a tabular form, presenting, at one view, the name of the observer, the place of observation, the nature of the occultation, the age of the moon, and her motion at the time whether northerly or southerly; information of a nature not easily to be abridged, and far too voluminous to have insertion in the monthly notices of the Society's proceedings.

On perusing them, however, we find that more than twenty stars have exhibited peculiarites at or on the moon's limb, prior to im-

mersion behind it, or emersion from it; that the anomalies are not confined to stars of a certain magnitude or colour; nor are they dependent upon any particular age of the moon. Most of them have furnished but solitary instances of peculiarity; viz. *Spica Virginis*, *γ Libræ*, 132 *Tauri*, *α*[1] *Cancri*, *λ Aquarii*, 249 *Aquarii*, 187 *Sagittarii*, *γ Tauri*, *ϱ Leonis*, *ϱ Geminorum*, *δ Cancri*, and *δ Piscium*. One, *Regulus*, affords three, whilst to *Aldebaran* we are indebted for no fewer than twenty instances of anomaly.

On reference to the list, the anomaly alluded to, it will be seen, stands not upon the testimony of a single individual, but is supported frequently by the evidence of a second, and sometimes even of a third person; occasionally they are co-observers at the same station; at other times they are at different parts of the same city; whilst in some instances, they are separated by a very considerable distance. On the other hand, the conflicting testimonies, where we should least expect to find them, are perplexing; a circumstance which, together with the vague manner in which the observations are frequently recorded, and the habit which, in many instances, unfortunately prevailed, namely, of observing the immersion and emersion of the same star, on the same occasion, with different telescopes, and the almost constant omission to register, if the moon's dark limb *was* or was *not* visible, enable us, Mr. South says, to do little more than to state, with some appearance of probability, what are *not* the causes of the phenomena.

The hypothesis advanced as explanatory of the phenomena in question, are then stated: viz. a lively imagination on the part of the observer; a spurious disk given to the moon's image by the instrument of observation; a lunar atmosphere; irradiation; and lastly, different refrangibilities to which the rays from the moon and star are liable, arising from their differences of colour.

As unfavourable to the first hypothesis, which would refer the phenomenon to a lively imagination on the part of the observer, Mr. South advances the fact, that "more than sixty instances of anomaly stand attested by such men as Messier, Troughton, Bouvard, Arago, and Mathieu; and that it is rather too much to suppose that all of them are liable to the imputation which such an hypothesis would require.

The second hypothesis, which supposes a spurious disk to be given to the moon's image, might, he observes, be entitled to some consideration, had refracting telescopes, whose object-glasses were not achromatic, been solely employed for the observations; but seeing that refractors, long and short, achromatic and non-achromatic; reflectors, Newtonian and Gregorian, most of which were probably far above the rank of good instruments, and some of which certainly might be brought forward as the most perfect specimens of optical ingenuity,—have all exhibited the anomaly, there is considerable difficulty in receiving the hypothesis, unless indeed we could grant that a constant cause should not produce a constant effect.

The next hypothesis offers a lunar atmosphere as the occasion of

the apparent projection of a star on the moon's disc. Were this the case, its effects would be similar upon all stars of similar colour; and should we not see evidence of its existence, in some shape or other, at every occultation which occurred? yet, how infinitely few are the instances in which any thing whatever is observable of alteration in the star on the moon's approach to it, indicated by derangement of its position, diminution of its splendour, or change of colour. Still it must be remembered, such changes do stand on record; but they are either so unsubstantiated, or are so referable to other causes than a lunar atmosphere, that we are scarcely warranted in lending ourselves to the hypothesis, to which they would conduct us.

The hypothesis next in order suggests irradiation as the source from which the anomaly is derived. It seems, however, Mr. South thinks, incapable of answering the purpose for which it is brought forward; seeing that projections of stars upon the moon's *dark* limb have been witnessed by Messier, by Maskelyne, by Arago, by Mathieu, and by himself.

That the last hypothesis — namely, that which supposes the apparent projection to arise from the different refrangibilities of the rays issuing from the star and moon — is not tenable, Mr. South advances the circumstance, that not only *Aldebaran* and the *red* stars are liable to the anomaly, but that stars as remarkable for their *white* light as is *Aldebaran* for its *red*, have exhibited the phenomenon of apparent projection. He also says that, as far as he knows, no instance of apparent projection of the planet Mars upon the moon's disc, is at present recorded amongst the list of lunar occultations of that planet; yet *Mars* is much more decidedly *red* than *Aldebaran*, or than any other star which has been observed on the lunar disc.

Having, as he thinks, shewn that the above hypotheses are inadequate to the purpose for which they have been designed, Mr. South states that he should not be justified in advancing any hypothesis in addition to those which he has combated; but concludes his paper by stating, that from the *Connoissance des Tems*, he finds that the moon's path will, during the years 1829 and 1830, furnish several occultations of *Aldebaran;* when it is to be hoped that a phenomenon, which has been so little observed in Great Britain, that if it rested solely on the authority of British astronomers would be scarcely entitled to any notice, will not longer furnish an object for their reproach.

J. Moyes, Castle Street, Leicester Square.

ASTRONOMICAL SOCIETY OF LONDON.

November 14, 1828. No. 14.

A PAPER, by Mr. James Epps, was read, containing "Tables for readily ascertaining the azimuthal deviation of a transit instrument from the meridian, by observed transits over the vertical it describes; with the method of reducing these observations to the meridian, and of determining the exact state of the clock in respect to sidereal time."

The author, having for some years been engaged in observing transits for the purpose of a scrupulous determination of time, was indispensably led to consider of the readiest method of keeping the instrument in the meridian, and *of correcting his observations for it's occasional deviations.* After trying several methods, no one was found so generally applicable as that recommended by Delambre, and dependent upon the observations of two well-known stars, passing the meridian at nearly the same time, and differing considerably in north polar distance. It is assumed that the axis of the instrument has been carefully levelled, and the error of collimation corrected, *i. e.* that the middle wire of the telescope describes a correct vertical circle. It is also supposed, that the clock is either going sidereal time, or that, from it's known rate, any observed interval can be reduced to sidereal time. Mr. Epps then investigates the form of the correction, and concludes, that if z be the deviation of the vertical from the meridian in seconds of time; α, the N.P.D. of the star; λ, the co-latitude of the place of observation, the correction to be applied to the observed time of transit is $\pm z.\frac{\sin(\alpha-\lambda)}{\sin\alpha}$ according as the deviation is to the east, or west, of the south horizon. Tables are given of $\frac{\sin(\alpha-\lambda)}{\sin\alpha}$ for every degree of N. P. D. from 15° to 130°, and for every 10′ of N. latitude from 51° to 53°. By an additional column, containing the variation of this factor for 2°, this table can be continued with equal accuracy from 49° to 55° N. latitude. Separate tables are constructed for α, β, δ, Ursæ Minoris, both above and below the pole. Several examples follow, in which the use of these numbers in ascertaining the state of the instrument and the true error of the clock are very clearly shewn. It is further recommended to observe several couplets of stars, and to take the mean result. If the instrument be reversed after half the observations are made, the determination of the absolute time will be still more accurate.

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ceding A three seconds of time, is a faint nebulous spot. The equatorial was now placed at R.A. $23^h\ 13^m$; declin. + 25° 43′; and at R.A. $22^h\ 53^m$; declin. + 24° 14′; but no nebula can be detected in either place, although the night is remarkably fine. By the transit instrument, the right ascension of the presumed comet was $22^h\ 48^m\ 50^s$. At $1^h\ 15^m$ sidereal time, it had materially altered its position relatively to the neighbouring stars, being considerably to the south of the star A, and nearer to C than to A. It is therefore, beyond all doubt, a comet; and as its place coincides so exactly with the calculated place of Encke's comet, it can be no other than *it*.

"*Wednesday, November 5th.*—This evening, at Slough, the comet was seen in the 7-feet, the 10-feet, and 20-feet reflectors, by Mr. Herschel, Lord Ashley, Dr. Wallich, and myself; since which time I have frequently seen it with the 5-feet equatorial; and on Wednesday night last, the moon being seven days old, and but a few degrees distant, it was still visible, and was seen by two of my visitors and myself.

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

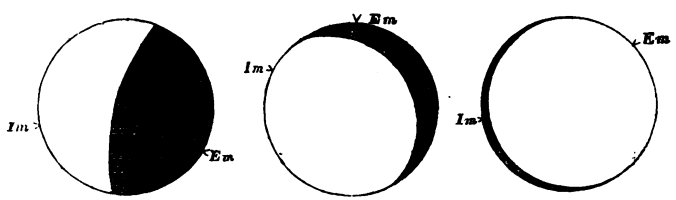
December 12, 1828. No. 15.

THE first paper read this evening was the following:—Occultations of Aldebaran by the Moon, in the year 1829, computed for ten different observatories in Europe, at the request of the Council of this Society, by Thomas Henderson, Esq. of Edinburgh, and Thomas Maclear, Esq. of Biggleswade, in Bedfordshire.

1829.	PLACE.	IMMERSIONS.			EMERSIONS.		
		Sidereal time.	Mean solar time.	Angle.	Sidereal time.	Mean solar time.	Angle.
		h m	h m	deg.	h m	h m	deg.
April 7....	Dorpat....	8 16	7 13	238	8 41	7 38	192
July 25.	Dorpat....	21 36	13 22	261	22 29	14 16	54
	Konigsberg	21 7	12 54	259	21 59	13 46	53
	Vienna....	below	the	horizon.	21 35	13 21	55
Aug. 21.	Dorpat....	6 8	20 7	297	7 19	21 18	121
	Konigsberg	5 38	19 37	284	6 51	20 50	134
	Vienna....	5 21	19 20	265	6 30	20 29	159
	Naples....	5 29	19 28	238	6 3	20 2	200
	Milan	4 43	18 42	247	5 47	19 46	164
	Paris	3 59	17 58	238	5 13	19 11	138
	Greenwich.	3 45	17 44	254	5 2	19 1	125
	Bedford...	3 45	17 44	258	5 2	19 1	120
	Edinburgh.	3 30	17 20	268	4 46	18 45	105
	Dublin....	3 12	17 11	257	4 28	18 27	107
Oct. 15.	Dorpat....	0 52	11 15	292	1 41	12 4	35
	Konigsberg	0 17	10 40	283	1 7	11 31	32
	Vienna....	23 45	10 8	265	0 41	11 4	34
	Naples....	23 22	9 45	243	0 22	10 46	41
	Milan	23 10	9 34	262	0 4	10 27	30
	Paris	22 51	9 14	280	23 35	9 58	19
	Greenwich.	22 48	9 12	292	23 25	9 49	12
	Bedford...	22 48	9 12	300	23 23	9 47	5
	Edinburgh.	22 50	9 13	313	23 12	9 35	358
	Dublin....	22 31	8 55	306	22 56	9 20	1

1829.	PLACE.	IMMERSIONS.			EMERSIONS.		
		Sidereal time.	Mean solar time.	Angle.	Sidereal time.	Mean solar time.	Angle.
		h m	h m	deg.	h m	h m	deg.
Dec. 9...	Dorpat ...	1 4	7 51	262	2 8	8 55	64
	Konigsberg	0 29	7 16	253	1 33	8 20	65
	Vienna ...	0 0	6 47	236	1 3	7 50	66
	Naples ...	23 42	6 29	215	0 41	7 28	69
	Milan	23 25	6 12	233	0 25	7 12	61
	Paris	23 1	5 49	249	23 59	6 46	51
	Greenwich.	22 57	5 44	257	23 53	6 40	47
	Bedford ...	22 56	5 43	260	23 52	6 39	45
	Edinburgh.	22 53	5 40	271	23 44	6 31	41
	Dublin ...	22 36	5 23	268°	23 27	6 14	39

The following are the phases of the three occultations which will be visible at Greenwich, as shewn in a telescope that does *not* invert.



The occultations in April and July will not be visible at Greenwich, although marked as such in the Nautical Almanack: nor will they be seen in any of the western part of Europe.

In the preceding ephemeris, the column marked *Angle* denotes the point of the moon's limb where the phenomenon will take place, reckoning from the vertex, or highest point of the moon's limb, towards the west, or right hand, round the circumference.

The object of the Council, in procuring these computations, has been to induce astronomers to look out for the occultations, with a view principally to determine whether Aldebaran will *appear projected on the face of the moon*, as has frequently been observed in former occultations of this star. It is therefore requested, that particular attention be paid to the following circumstances: viz. 1. whether the star undergoes any change of light, of colour, or of motion, on its immediate approach to the edge of the moon; 2. whether it appears to be projected on the moon's disc, and for how long a time; 3. whether the dark limb of the moon be distinctly visible and well defined at the time of the phenomenon; 4. whether the star, on its emersion, appears on the moon's disc, or emerges quite clear of the moon's border.

In recording the observations, it is desirable that the observer should describe the telescope made use of, and that the same instrument should be employed in observing both the immersion and emersion; that it should be noted whether the telescope was adjusted to the moon or to the star, and whether it had been altered during the observations. And as it is probable that the phenomenon may differ in some slight particulars, even to persons observing together in the same place, it is hoped that the actual appearances will be recorded (as they may present themselves) by each person, without suffering his impression to be biassed by the opinion or representation of others.

It is further requested, that, in recording such observations as may be made, the *correct* time (as well as the place) of observation may be given; that is, the time shewn by the clock *corrected* for its *error*, in order that comparisons may be made of the best mode of computing occultations. Two different methods have been pursued in computing the ephemeris here given; and although the results have agreed sufficiently near to enable the Council to ascertain the time to the nearest minute, yet, in some of the cases, the results have varied from each other much more than might have been expected. The computations will probably be revised and investigated, when the correct time and place are ascertained.

The next paper was "On the determination of the Constant of Aberration of Light, from 4119 observations made at the Royal Observatory at Greenwich, during the years 1825, 1826, 1827, and 1828, with the two mural circles of Troughton and Jones, by Mr. William Richardson." The author remarks, that, after the great labour bestowed on the subject of aberration by those eminent astronomers, Bradley, Delambre, Bessel, Lindenau, Brinkley, and Struve, it might appear superfluous to attempt the exact determination of an element, the amount of which is known within such small limits. However, as this attempt has never been made from the Greenwich observations, since the time of Bradley, and as the two mural circles erected there, together with the method now adopted of observing alternately by reflection, afford such powerful means of detecting the most minute variations in the apparent motions of the heavenly bodies, the author conceived that the results of observations made under such favourable circumstances might be highly acceptable to the practical astronomer. With this view he has undertaken the reduction of upwards of 4000 recent observations of 14 of the Greenwich stars most favourably situated for determining this element, those having been selected which are the most affected by aberration, and the least affected by refraction; whereby the errors of observation have the least possible influence on the result. It will be seen, by the following Table, that the final result (giving equal weight to each observation) obtained by Troughton's circle is 20″,505, and by Jones's circle 20″,502; and, for the sake of round numbers, Mr. Richardson proposes to adopt 20″,5 as the most probable value of the constant of aberration.

This value is somewhat greater than that proposed by Dr. Brinkley and Mr. Struve, and recently adopted by this Society; but rather less than the values deduced by MM. Bessel and Lindenau.

Names of the Stars.	TROUGHTON'S CIRCLE.			JONES'S CIRCLE.		
	Const. of Aberr.	No. of Obs.	Cons. of Aber. × No. Obs.	Const. of Aberr.	No. of Obs.	Cons. of Aber. × No. Obs.
α Cassiopeæ	20·137	80	1610·960	20·408	80	1632·640
Polaris	20·246	160	3239·360	20·213	152	3072·376
———, by ref.	20·390	73	1488·470	20·201	72	1454·472
——— S. P...	20·767	150	3115·050	20·973	150	3145·950
———, by ref.	20·427	70	1429·890	20·285	62	1257·670
α Ursæ Majoris..	20·723	80	1657·840	20·594	80	1647·520
ζ ———— .	20·411	80	1632·880	20·575	80	1646·160
η ———— .	21·028	80	1682·240	20·733	80	1658·640
α Draconis.....	21·059	80	1684·720	21·436	80	1714·880
β Ursæ Minoris .	20·924	80	1673·920	21·112	80	1688·960
γ Draconis.....	20·577	240	4938·480	20·456	240	4909·440
α Lyræ	20·403	160	3264·480	20·324	160	3251·840
——, by ref...	20·267	35	709·345	20·712	32	662·784
β ——	20·146	80	1611·680	20·424	80	1633·920
δ Draconis	20·597	160	3295·520	20·376	160	3260·160
α Cygni.....	20·354	123	2503·542	20·112	128	2574·336
——, by ref..	20·359	80	1628·720	20·732	80	1658·560
α Cephei	20·373	137	2791·101	20·265	132	2674·980
β ———	20·386	118	2405·548	20·358	125	2544·750
	389·574	2066	42363·746	390·291	2053	42090·038
Means.....			20,505			20,502

Lastly, there was read a paper by Mr. James Epps, upon the inclination of the axis of the transit instrument, with accompanying Tables.

If the pivots of a transit be equal, but the axis not horizontal, the circle described by the instrument will not pass through the zenith, but at a certain distance from it, which is readily *measured* by the level. It is not always easy to correct this inclination with the utmost accuracy; neither will an instrument preserve this adjustment when made, except under very favourable circumstances: hence a correction must be applied to the observed R.A. of a star, in order to obtain the R.A. which would have been observed if the axis had been truly horizontal.

Now, if i be the inclination of the axis in seconds of time, as determined by the level; α the N.P.D. of the star; L the latitude, λ the co-latitude of the place of observation; Mr. Epps shews, that the correction required $= i \times \frac{\cos(\alpha-\lambda)}{\sin \alpha}$ or $i\,(\cos \mathrm{L} + \sin \mathrm{L}.\cot \alpha)$ to be added to the observed R.A. when the west end of the axis is elevated, and *versâ vice*. Below the pole these signs are changed.

The present Tables contain a factor $m = cos\ \mathrm{L} + sin\ \mathrm{L}.\ cot\ \alpha$, and are precisely similar to those already given by Mr. Epps for the azimuthal deviation; viz. for every 10′ of latitude, from 51° to 53° inclusive, with a column of the variations for 2 degrees of latitude. Hence, having at any time the value of the inclination i, expressed in sidereal time, we have merely to find m by the Tables, when the product $m\,i$ will be the reduction of the observation to the meridian.

It may be proper to add, that in finding the azimuthal deviation of the instrument by the observed transits of two stars, according to the method shewn in a former paper, the observations should be previously corrected for the errors arising from the inclination of the axis, and also for the error of collimation, should such an error exist.

A letter was read from Dr. Lee, requesting the Society to accept of the two-feet meridian circle, divided on gold, by Troughton, for the late Rev. Lewis Evans.

A letter was also read from Dr. Wollaston, presenting to the President and Council of the Society his fine triple object-glass achromatic telescope, made by the late Mr. Peter Dollond, in the year 1771, and which he had himself adjusted agreeably to the method laid down by him in the *Philosophical Transactions* for 1822.

[The Council take this opportunity of announcing to the members, that *blank forms* for registering observations with the transit instrument and with the meridian circle or quadrant, have been printed at the expense of the Society, and that any member may be supplied with some copies thereof, on applying to the Secretary for that purpose.]

J. NOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

January 9, 1829. No. 16.

THE President read an extract from a letter of Professor Encke, dated Berlin, Dec. 7, 1828, in which he states the following places of his comet, as the results of his own observations: —

Date.	M. T. Paris.	A. R.	Declin.	Calcul.—Observ. A.R.	Calcul.—Observ. Dec.	
1828.	h m s	° ′ ″	° ′ ″	′ ″	′ ″	
Oct. 13	8 52 0	7 17 45	+28 44 57	−2 3	+ 16	Dorpat.
27	6 34 28	351 57 40	26 41 4	2 4	− 31	Berlin.
Nov. 4	7 29 45	342 10 52	23 50 25	2 27	1 16	—
5	8 26 42	340 55 31	23 22 50	2 12	20	—
10	6 34 51	335 8 39	21 25 50	2 17	21	—
13	10 39 32	331 34 55	19 25 0	2 17	19	—
25	6 1 17	319 29 48	12 50 23	3 0	51	—
26	6 4 33	318 32 13	12 15 57	3 11	1 23	—
Dec. 2	6 4 13	312 49 58	8 40 38	3 35	1 1	—
5	5 53 15	309 56 34	+ 6 49 15	−3 36	−1 42	—

" These errors," he observes, " follow a law different from the changes which would have taken place if the passage through the perihelion had been ill determined. I do not, therefore, think that this element is liable to any great correction. I have computed an ephemeris by M. Damoiseau's elements, which vary from mine only in the perihelion passage, and I find the following differences: —

	A. R.	Dec.
1828.—Oct. 10.	−0° 10′ 12″	− 5′ 52″
18.	7 29	7 39
26.	− 2 10	8 45
Nov. 3.	+ 5 31	8 23
11.	14 31	6 5
19.	23 50	2 13
27.	33 34	− 2 37
Dec. 5.	44 16	+ 8 53
13.	0 56 26	16 14
21.	1 7 55	23 34
29.	+1 8 18	+25 32

" According to these elements, the errors would have undergone a variation of nearly 50′ in right ascension between the 13th October and the 5th December."

A paper was next read " On the determination of the distance of a Comet from the Earth," by J. W. Lubbock, Esq. M.A.S. The author in this paper proposes to examine the principle of the various methods which have been proposed for the resolution of this problem,—to bring them under one notation,—and to ascertain from which *the greatest advantage is to* be expected.

In problems of physical astronomy, where an approximate solution is to be obtained from observations embracing an interval of time, short in comparison of the whole period of the phases of the phenomena, we may express the successive differential coefficients of any function in terms of the finite differences of the function itself, by formulæ well known to geometers. In that under consideration, the distance of the comet from the earth is the unknown quantity; and by means of a well-known theorem, that distance at the first and third observations may be expressed in terms of the distance at the second and known quantities. By substitution, then, in the differential equations of the comet's motion, or in any of their integrals, we may obtain equations in which the comet's distance from the earth is the only unknown quantity, and which furnish so many different methods of determining that distance.

The author exemplifies this by instances drawn from the *Méchanique Céleste*, and the work of M. Legendre, "On the Determination of Comets' Orbits;" where the equation denoting that the velocity of the comet at the second observation is equal to that of a body describing the chord uniformly in a time equal to that of describing the arc between the extreme observations, is derived from the general expression of the velocity in terms of the radius vector. This is the principle on which Newton's method in the *Principia* is founded. He then shews how the equation given by Lagrange in the *Méchanique Analytique*, vol. ii. p. 57, is derivable from the same system of substitution; but he remarks, that Lagrange has there stated this equation incorrectly, and gives what he considers the correct statement; and he applies the same principle to deduce the equation employed by Mr. Ivory in his paper on this subject.

The author then states, that by a peculiar combination of the fundamental equations and their derivatives, not before noticed, he has succeeded in reducing the final equation for determining the comet's curtate distance, from the seventh degree to a quadratic, — a reduction which had been supposed impracticable.

Having reduced all the equations employed in the various methods to one notation, he includes them in a printed form adapted to their reduction to numbers by logarithmic computation, and exemplifies its use in the determination of the elements of the celebrated comet of Halley, from three observations of Messier. The ellipse deduced by his method, as a first approximation, is, he remarks, equally correct with that of Klinkenberg, which Olbers and Delambre have adopted.

He concludes with some remarks on the correction of approximate elements; and he accompanies his paper with a copy of the printed skeleton form employed, and with the whole of the numerical computations in a separate volume.

There was also read a paper on the longitudes of Calcutta, Madras, and Futty Ghur, as determined by lunar transits and *eclipses of Jupiter's first satellite*, by Major J. A. Hodgson, Sur-

veyor-General of India, accompanied with the original observations and reductions.

The longitude of the place of observation is computed from the R.A. of the moon and principal fixed stars, as given in the Nautical Almanack, the absolute time and corrections for the errors of the transit instrument being obtained from Greenwich stars advantageously situated for the purpose.

Longitude of Calcutta.

	h	m	s	
By 93 culminations of the moon's preceding limb	5	53	34,892	E
By 90 culminations of the moon's succeeding limb			17,563	
Mean	5	53	26,227	
Reduction to the flag-staff of Fort William.....			— 5,069	
East longitude of the flag-staff of Fort William	5	53	21,158	
Or,	88°	20′	17″,37	

These observations will be continued; and it is probable that when a more powerful instrument, now expected from England, is used, the results from opposite limbs of the moon will be closer.

Longitude of the Madras Observatory.

	m	s	
By 8 corresponding immersions of Jupiter's first satellite, Madras Observatory	31	59,66	West of flag-staff, Fort William.
By 9 corresponding emersions of Jupiter's first satellite, Madras Observatory	32	25,88	
Mean.....	32	12,52	
East longitude of Fort William flag-staff ...	5 53	21,16	
East longitude of Madras Observatory	5 21	8,64	

Mr. Goldingham (Ast. Soc. Mem. vol. iii. p. 268) gives for the longitude of Madras, $5^h\ 21^m\ 9^s,4$.

All these observations were made at Calcutta by Major Hodgson, and at the Madras Observatory by the same observer; the focal length, aperture, and power of the telescopes being the same.

Longitude of Futty Ghur, a military station on the Ganges. (27° 21′ 35″ N. lat.)

[Telescopes and observers as above.]

	m	s	
By 5 corresponding immersions of Jupiter's first satellite, Futty Ghur	2	52,98	West of Madras Observatory.
By 5 corresponding emersions of Jupiter's first satellite, Futty Ghur	2	12,24	
Mean	2	32,61	
East longitude of Madras Observatory	5 21	9,37	by Mr. Goldingham.
East longitude of Futty Ghur.....	5 18	36,76	
Or using Major Hodgson's long. of Madras,	5 18	36,04	
The mean of ten observations computed from the N. A. give	5 18	35,6	
A few lunar transits	5 18	37,1	

" The use of the transit telescope is becoming more general in Hindoostan, and by *it differences* of meridians will be better deter-

mined than by any other astronomical means. Over the greater part of those level and valuable countries which extend from the Indus to the eastern extremities of the valley of Assam, it is impossible to carry a series of great triangles. The differences of meridians of *distant* places must therefore depend upon careful astronomical observation of lunar transits and eclipses of Jupiter's satellites, or the transference of time by chronometers."

" Naval and military officers, who have more opportunities of multiplying useful observations than any other class of men, seldom fail, where they have it in their power, to turn to good account the instructions of astronomers, when they are stated in plain language, and illustrated by examples precisely and clearly arranged."

The last paper read was from Mr. Rumker, the astronomer at the Paramatta Observatory, detailing the observations for determining the December solstice in 1827, with one of Reichenbach's repeating circles; and likewise the observations of certain circumpolar stars, about the same period of time, by means of the mural circle. In reducing the observations for the solstice, Mr. Rumker (on account of the small zenith distance of the sun) applies a correction different from that given by M. Biot in his *Astronomie*. The result of his observations makes the mean obliquity of the ecliptic, reduced to January 1, 1828, equal to 23° 27′ 40″,01.

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

February 13, 1829. No. 17.

Report of the Council of the Society to the Ninth Annual General Meeting, held this day.

NINE years have now elapsed since the establishment of this Society; and the Council cannot but again congratulate the members on the increasing interest which it excites, and which there is every reason to believe will continue to be maintained.

One of the first acts of the present Council was to cause an ephemeris of Encke's comet to be circulated, not only amongst the members of this Society, but also amongst such persons, in distant parts of the world, as were likely to make good use of it, hoping thereby to increase the number of well-authenticated and recorded observations of that singular and remarkable body, and thus facilitate the means of rendering it's theory more perfect. It's re-appearance excited a considerable degree of interest, not only amongst astronomers, but the public in general; and it's observed places verified, in an astonishing manner, the accuracy of the computations of the distinguished astronomer, whose name the comet bears. This comet, as well as that of 1825, known on the continent by the name of Biela's comet, will again appear in the year 1832; and there is no doubt but that the Council also of that day will direct their attention to the best mode of procuring observations of both those newly discovered attendants on our system.

The attention of the Finance Committee, appointed during the last year, has been directed to a new mode of arranging the accounts of the Society, whereby the labours of each successive Council, in auditing such accounts, will be considerably abridged. In the pursuit of this inquiry, they have discovered, amongst the arrears which have been annually brought forward as assets of the Society, some that appear to be due from deceased members, in consequence either of their not having been claimed within a reasonable and proper time, or from the names of the parties having been continued on the list of members, for want of a due notification of their decease; others that, on a minute examination by your Council, appear to be irrecoverable, either from the incompetency of the parties, or from some ambiguous interpretation of the regulations of the Society. Under these circumstances, the Council have considered it advisable to strike those sums out of the annual accounts, and to bring forward only those arrears which there may be a fair prospect of recovering; reserving for a separate and distinct list such sums as are doubtful, and the discharge of which must be left

entirely to the honour and feelings of the parties interested. The Council have taken such steps as they think will prevent a recurrence of this evil; and they trust that the General Meeting will approve the measures here adopted, which must tend to shew them, in a more proper manner, the correct state of their accounts, and the true situation of the affairs of the Society.

The following abstract of the receipts and expenditure during the preceding year, will shew the present state of the funds of the Society; viz.:—

Receipts.	£.	s.	d.
Balance of last year.....	243	9	3
Arrears, Feb. 1828:—			
Resident members	40	19	0
Non-resident	8	8	0
Ditto, which had been remitted	2	2	0
Contributions for 1828-9:—			
4 admissions.....	16	16	0
56 resident members	117	12	0
2 compositions.....	50	8	0
7 non-resident	58	16	0
1 year's dividend on 800*l.* Consols..	24	0	0
1 yr.'s do. on 857*l.* 13*s.* 8*d.* new 4 per cents.....	34	6	0
Sale of the Memoirs, By the collector, 32*l.* 18*s.* By the booksellers, 45 0	77	18	0
	£674	14	3

Expenditure.	£.	s.	d.
3 gold medals	29	19	9
2 pendulums	34	4	0
Printing	147	2	5
1 year's rent to Michaelmas	52	10	0
1 composition invested, omitted in last year's account.....	25	4	0
Copper-plate printing	4	18	6
Stationary and stamps	9	0	0
Autograph book, &c.	7	2	0
Commission to collector ...	15	13	6
Petty disbursements at the apartments....	7	9	6
Postages, &c.	6	7	3
Balance	335	3	3
	£674	14	3

And the assets and present property of the Society are as follow; viz.:—

Assets of the Society.	£.	s.	d.
Balance in the hands of the treasurer	290	3	3
Due from Messrs. Baldwin and Co., booksellers	45	0	0
Bill not yet due	18	1	0
Arrears, Feb. 1828:—			
1 admission-fee.....	4	4	0
3 contributions of two years' standing	12	12	0
4 ditto, of one year's do.	8	8	0
Arrears of 1828-9:—			
3 admission-fees	10	10	0
27 contributions of 1 year's standing.....	56	14	0
5 non-resident contributions	42	0	0
	487	12	3
Stock in the funds; viz.:—			
800*l.* Consols..... ..... } valued at about	1570	0	0
857*l.* 13*s.* 8*d.* new 4 per cents..... }			
Books unsold, now on hands:			
The several instruments already alluded to:			
Gold and silver medals, unappropriated; &c.			
From the above, however, are to be deducted—			
A bill due to Mr. Robinson, for microscopes	22	5	0
The printer's bill for the second part of Vol. III., not yet completed.....			

The thanks of the Society are due to the Finance Committee, for the time and attention which they have bestowed on this subject, and for their efforts in arranging and simplifying the accounts; but more especially to your indefatigable and zealous secretary, Mr. Stratford, who originated that Committee, and who has ever, on this as on all other occasions, and at a sacrifice of much valuable time, and in the midst of other numerous and important avocations, not only devoted himself to the advancement of astronomy, and the means of diffusing its benefits amongst mankind, but has also infused life and vigour into every measure suggested for promoting the objects of the Society, and for maintaining its respectability and independence.

But, whilst the Council can thus truly congratulate the Society on the continuance of this strength and zeal in the cause of their favourite science, they cannot but lament the loss of his excellent coadjutor, Dr. Gregory, who has, for a long time past, been prevented by ill health from attending the meetings of the Council and Society. Dr. Gregory was one of the original founders of this institution, and has ever shewn the greatest zeal in promoting it's interest and welfare. Constant in the discharge of his duties, whenever his health would permit, the Society has long witnessed his exertions in their cause; and although at present unfortunately deprived of the benefit of his powerful talents, they still look forward with hope that he will soon again be able to join their meetings, and assist them with his counsel and advice.

The total number of members and associates is 264; and the increase since the last anniversary, according to their several classes, as well as the present state of the Society, may be seen from the following abstract; viz.:—

	Compounded.	Resident.	Non-resident.	Honorary.	Total Members.	Associates.	Grand Total.
Feb. 1828 . .	38	88	89	1	216	32	248
Since elected	2	7	12	—	21	—	21
Since lost . .	—	4	1	—	5	—	5
Feb. 1829 . .	40	92	99	1	232	32	264

Amongst the accessions to the list of members during the course of the preceding year, the Council notice, with the most gratifying feelings, the name of His Royal Highness the Duke of Sussex, the patron of every good and useful undertaking, and a prince highly distinguished for his zeal in promoting every branch of science.

The Society has to lament the loss, by death, of two only of its members during the past year. These are Captain Pringle Stokes,

of the Royal Navy, who was engaged in surveying the coasts of South America; and Dr. William Hyde Wollaston.

To Dr. Wollaston every part of science seemed equally familiar; and of him it might perhaps be more truly said than of any philosopher who has preceded him, that "*nil erat quod non tetigit, nil tetigit quod non ornavit.*" Astronomy was one of his chief and favourite pursuits—a taste inherited from his father, and cherished by his intimacy with the late Astronomer Royal of Dublin (now Bishop of Cloyne) and the present Astronomer Royal of Greenwich—an intimacy commenced in early youth at Cambridge, and maintained through life. Science is indebted to him for many ingenious and important speculations; such are his papers published in the Philosophical Transactions, on horizontal refractions, and on the horizontal refraction and dip of the horizon, containing his curious and ingenious invention of the dip sector. Among the most remarkable of his astronomical papers, however, is that on the finite extent of the atmosphere, which affords a striking instance of the advantages that may accrue to science by the union of remote branches of knowledge in the same mind. The arguments brought forward in that paper in favour of the non-divisibility of matter *in infinitum*, from astronomical phenomena, carry with them at least every semblance of soundness, and afford a singular specimen of his acute and scrutinizing habit of thought; while the almost miraculous delicacy and curious felicity of his manipulation in the practical departments of science—that microscopic tact, which in a thousand instances led him, through routes impervious to grosser intellects, to the most striking, unexpected, and novel results—is there exemplified in a remarkable manner, in the minute and apparently insignificant apparatus with which he was enabled to verify his own views, under circumstances which would effectually baffle ordinary instruments and ordinary observers.

The sister science of optics is even more indebted to Dr. Wollaston than astronomy. His verification of the Huygenian law of double refraction; his investigation of the refractive and dispersive powers of bodies, as a separate branch of physical inquiry, on which the perfection of the achromatic telescope depends; his discovery of the dark lines in the spectrum, since independently observed, with more refined means, and in greater detail, by Fraunhofer; but chiefly as concerns our science, the ingenious and elegant method practised by him for perfecting the adjustment of the triple achromatic object-glass, give him the highest claims to eminence in this department. The instrument on which he tried and perfected this mode of adjustment is now, through his liberality, the property of this Society.

The Council think it right to include in this Report the letter containing his announcement of this valuable gift.

Dorset Street, Dec. 8, 1828.

My dear Sir,—Being in possession of a telescope which I hold in great estimation, and being desirous that its good

qualities should be properly appreciated, and that it may become useful, I think I cannot do better than present it to the President and Council of the Astronomical Society of London.

I annex a memorandum of my wishes in regard to the destination of the telescope, as well as to what regards its origin. I have had it properly put in order by Dollond, and I now send it to you, as President of the Society, to be held at the disposal of the President and Council.

As I highly appretiate the honour of being a member of that Society, so I heartily wish them success in the very interesting and laudable object of their pursuits, and am, with sincere respect and regard,

Most truly yours,

J. F. W. Herschel, Esq. V.P.R.S. W. H. WOLLASTON.
President of the Astronomical Society of London.

Memorandum alluded to in the foregoing letter.

This telescope is presented by Dr. Wollaston to the President and Council of the Astronomical Society of London, in hopes that they will not keep it useless, but lend it, or give it if they think proper, to any industrious and useful member of the Society, he not being at the time a member of the Council.

The telescope was made by Mr. Peter Dollond, in the year 1771, for the Rev. Francis Wollaston, F.R.S., who valued it very highly. Dr. Wollaston thinks that he has even improved it by screws added for the concentric adjustment of the object-glass, as described in the *Phil. Trans.* for 1822, p. 32.

The injunction contained in this letter, to render the instrument available for purposes of actual observation, has been complied with. It has been placed in the hands of Mr. Maclear, of Biggleswade, a member of the Society, for the purpose of enabling him to observe a series of occultations, computed by himself, of Aldebaran by the moon, and other similar phenomena.

Almost the last astronomical labour of Dr. Wollaston was a series of observations of a peculiar photometrical nature, for determining the relative brightness of the stars and of the sun. It has not yet been made public; but the results are such as to open new and more magnificent views of the constitution of the universe than even any which had preceded them.

Dr. Wollaston was born on the 6th of August, 1766, at East Dereham. He became a Tancred fellow of Caius College, Cambridge, shortly after taking his degree, and continued to reside there till 1789. He then removed to London for the improvement of his medical knowledge, and continued the practice of physic till the end of 1800, when an accession of fortune determined him to relinquish a profession he never liked, and devote himself wholly to science. It is from this period that we are to consider him as a public character in science. As a commissioner of longitude, he was ever

solicitous to promote whatever seemed likely to prove of practical utility, and render the longitude easy of measurement and calculation. Any well-grounded project for the improvement of chronometers was sure to find in him a firm supporter. The system of determining differences of longitude by sets of itinerant chronometers, as practised by Dr. Tiarks and Captains Foster and King, was warmly advocated and effectually supported by him.

Dr. Wollaston was many years a Vice-President of the Royal Society, and for a short time filled the chair of that illustrious body in 1820. He became a member of this Society in November 1828, under circumstances of which the irregularity could only be justified by the urgency of the case, and the impossibility of its being drawn into a precedent in future. Dr. Wollaston was proposed in the June meeting, and his certificate having hung till the following November, he ought, according to our rules, to have been balloted for at the ensuing meeting. The alarming situation of his health, and high probability of his dissolution previous to the December meeting, induced the Council at once to recommend to the meeting a departure from the established rule, and that the election should take place on the day already named; which was done, and received the unanimous sanction of the meeting, who insisted on dispensing with the formality of even a ballot. But the Council feel, that though such a case may justify the step, they must look to the general body of the members, now assembled on their anniversary, to ratify it, which they confidently expect will be done. His death took place shortly after; viz. on the 22d December, 1828.

At the last anniversary meeting, the Council reported the liberal donation, by Lieutenant George Beaufoy, of his father's astronomical instruments. They have this year again to congratulate the Society on two other distinguished marks of liberality and public spirit on the part of two of its members. The one, by Dr. Wollaston, of one of Dollond's celebrated triple object-glass achromatic telescopes, as already noticed: the other, by Dr. Lee, of one of Troughton's two-feet altitude circles, formerly in the possession of the Rev. Lewis Evans, a member of this Society. Dr. Lee purchased this instrument expressly for the Society; and the communication of the present was conveyed in the following very handsome letter, addressed to the Secretary, viz.: —

5, College, Doctors' Commons, Dec. 9, 1828.

Sir, — Having accidentally heard from that indefatigable officer, Captain Smyth, of the Observatory at Bedford, that a two-feet altitude circle, divided on gold, was to be procured, in consequence of the death of the Reverend Lewis Evans, of the Astronomical Society, I have had the good fortune to become the possessor of it.

Being deeply impressed with the conviction, that the establishment of the Astronomical Society of London must prove of great beneficial influence in diffusing a science justly considered as the summit of human acquirements, I consider it

one of the most gratifying events of my life to have been admitted into that useful and learned body; and being desirous of marking the high sense which I entertain for its zealous exertions in so noble a cause, I humbly request that the Society will honour me by accepting the above-mentioned circle, especially as I am informed that it is a production of the best days of the illustrious Troughton.

I have the honour to subscribe myself,
With much respect,
SIR,
Your faithful humble servant,
JOHN LEE.

W. S. Stratford, Esq.
Secretary to the Astronomical Society.

This accession of strength in the department of Instruments induced your Council to form a Committee for drawing up a code of regulations, to be observed not only in the appropriation of these and other instruments that may come into the possession of the Society, but also by those who may require and obtain the loan of them; a measure which they trust will ensure the free and impartial use of them to such members as devote themselves to practical astronomy, without impairing the rights and claims of the Society to the property thus temporarily parted with; — hereby promoting their principal objects — the acquisition and diffusion of useful information. Copies of these regulations are printed, and will not only be circulated in the next monthly notices of the Society, for the information of the members at large, but will likewise be affixed to all the packages that contain the instruments.

It was stated in the last annual report, that the altitude and azimuth instrument, and the transit instrument (presented to the Society by Lieutenant Beaufoy), had been lent to Captain Smyth, of the Royal Navy. But Captain Smyth being desirous of exchanging that altitude and azimuth instrument for the altitude circle presented by Dr. Lee, and this being in accordance with the wishes of Dr. Lee, the Council have assented thereto. The altitude and azimuth instrument, therefore, presented by Lieutenant Beaufoy, being thus again at the disposal of the Council, they have granted the loan of it to the Rev. Michael Ward, one of the members of this Society, whose zeal in the cause of astronomy is well known, and in whose hands this instrument will not remain idle.

The triple object-glass achromatic telescope, presented by Dr. Wollaston, has been placed (as already mentioned) in the hands of Mr. Maclear, of Biggleswade, another of your members, and to whom the Society is indebted for the computations of the occultations of Aldebaran for the present year, to which your Council will more particularly allude in the sequel. This gentleman has paid considerable attention to this branch of the science; and it is hoped that he will, amongst his other pursuits, and as opportunities may from time to time offer, help to fill up, by means

of this instrument, the void that has been made in this class of detached observations by the death of the late Colonel Beaufoy.

In the last Report it was stated, that two invariable pendulums, belonging to the Society, had been intrusted to the care of Captain Foster, in his present scientific voyage. The Council have not yet received any official communication from that active and intelligent officer; but they have heard that he was prevented, by ill health, from swinging these pendulums at Monte Video; and that he proposed to swing them at Staten Island, to which place he was about to proceed.

One of the clocks, alluded to in the last Report, as presented by Lieutenant Beaufoy, is in the hands of Mr. Herschel, your President.

Thus, it will appear that the whole of the instruments presented to, and purchased by, the Society are in a state of activity, and placed in such hands as are likely to use them for the promotion and advancement of the science, — the true end and object of this institution.

In order to facilitate and encourage the recording of observations, and with a view of preserving an uniformity to the methods usually adopted in the public observatories, the Council have caused *skeleton-forms* to be printed on large ruled paper, so as to be bound up together in a book. One set of these forms is intended for the transit instrument, and the other for a meridianal circle, or quadrant. And those members, to whom such forms may be practically useful, may have copies of the same, on application to the Secretary.

The subject of Occultations has at all times been an interesting and important one, both to the practical and theoretical astronomer; and they frequently present some remarkable phenomena with respect to light, when the edge of the moon comes in contact with the star about to be occulted, — the star sometimes appearing to be *projected on the disc of the moon.* This circumstance has been more particularly alluded to, and numerous instances given, in a recent paper read before the Society by Mr. South; wherein he remarks, that this appearance is more frequent (at least more frequently recorded) as to Aldebaran, than as to any other star, accompanied, however, with anomalies for which it is difficult to account. As the present position of the moon's nodes is such as to cause her to pass over Aldebaran at every lunation for some time to come, the Council have thought it would be gratifying to the members, and also promote the interests of science, if they procured the computation of all the occultations of Aldebaran that will be visible in this quarter of the globe during the present year. This subject was no sooner mentioned, than two gentlemen, well known for their zeal in astronomy, and for their knowledge of the subject, kindly undertook the labour of the calculations: and the Society are indebted to Mr. Maclear, already mentioned, and Mr. Thomas Henderson of Edinburgh, for the ephemeris of the occultations of

Aldebaran, which has been circulated in the monthly notices, — and for which mark of attention and public spirit, the Council and Meeting have awarded their thanks. Your Council, conceiving that it would advance the interests of astronomy to obtain as great a number of observations as possible, have caused an extra number of copies to be struck off, with a view to circulate them in various parts of Europe, and thus induce astronomers to look out for, and record, the phenomena which they may observe.

Towards the close of the year now expired, your Council have devoted, as usual, one of their meetings to a consideration of the subjects for which they conceived the Medals should be awarded, agreeably to the original views and intention of the Society. And they have resolved to give one of the gold medals to each of the three following persons, viz.: to the Rev. Dr. Pearson, Treasurer of this Society, for his recent Treatise on Practical Astronomy; to Professor Bessel, of Königsberg, for his numerous and important astronomical observations, particularly those made in *zones;* and to Professor Schumacher, of Altona, for his various scientific publications, especially his *Astronomische Nachrichten,* which has rendered such essential aid to the progress of astronomy. These Medals will be delivered by the President, in the usual manner, at the close of this meeting.

But although the Council have marked, in this expressive manner, their opinion of the works above alluded to, they have not been insensible to the merits and claims of other labourers in the cause of astronomy. And, amongst the various papers read at the meetings of the Society during the preceding year, your Council cannot refrain from noticing the very laborious and important one by Mr. William Richardson, " On the Amount of the Constant of Aberration," which has been the result of computations made on upwards of 4000 observations of such stars as are favourably situated for the accurate determination of this element. Mr. Richardson is well known to this Society as one of the computers of the Catalogue inserted in the Appendix to the second volume of the Memoirs, — the whole of which passed through his hands. In undertaking the arduous task, however, of computing the *constant* above alluded to, he has been actuated only by his inherent and ardent love of science, and has had solely in view the promotion of astronomy, even in its most minute branches. Employed in the active duties of an observer at the Royal Observatory at Greenwich, he has devoted his leisure hours to the investigation of a subject, which requires labour and attention sufficient to appal the most strenuous supporter of astronomy, and a sacrifice of time by no means indicated by the minuteness of the final result obtained. Mr. Richardson's paper was not presented to the Society till the last meeting; and your Council regret that the short period which has elapsed has prevented them from passing a more decided expression of their sentiments on its merits.

There are few things that tend more to the promotion of astronomy, either theoretical or practical, than the publication of an

accurate and comprehensive ephemeris, whereby the observer may be informed when and where to look out for the various phenomena that may be expected to occur from time to time. This is indeed a subject of such obvious necessity, and of such national importance, that every enlightened state has hitherto encouraged and patronised the publication of such a work. It was reserved, however, for the present era to witness one of the most complete productions of this kind that has ever yet appeared; and edited, moreover, by one of the most distinguished astronomers in Europe. Your Council evidently allude to the astronomical ephemeris, lately published at Berlin, by Professor Encke, for the year 1830, and intended to be annually continued. In this work, the practical astronomer will find, ready to his hands, every information that may be required in the active discharge of his duties in the observatory, and stated with a degree of order and minuteness unparalleled in productions of this kind. No subject seems to have escaped the attention of this celebrated astronomer, who appears to be sensible of all the wants that attend an observer. With a bold but discriminating hand, he has struck out a new path for the formation and arrangement of a national ephemeris, of which he may be justly proud, and which does honour to the country under whose auspices it has appeared.

Whilst the Council thus congratulate the members on the advancement of astronomy in the northern hemisphere, they cannot be insensible to the benefits to be derived also from the progress of the science in the south. The rich harvest brought to this country by the activity and perseverance of Sir Thomas Brisbane and Mr. Dunlop will be followed up by new labourers in the field, from whom there is a prospect of further additions to our store of knowledge. For it is understood to be in the contemplation of government to adopt the observatory at Paramatta, already so distinguished in the annals of astronomy: and it is hoped that the opinion expressed by your Council on this subject (in consequence of a communication from the President of the Royal Society) will have some weight in promoting the objects of astronomy in that hemisphere.

The Council take this opportunity of announcing, that the printing of the second part of the third volume of the Memoirs is very nearly finished; and that it is intended that this shall complete the volume. The delay which has arisen must be attributed in a great measure to the numerous calls that have been made during the last year on the time and attention of your indefatigable Secretary, Mr. Stratford, on whom, indeed, (in consequence of the lamented illness of Dr. Gregory), the whole duty of the office has devolved.

The Council have thus endeavoured to give a brief abstract of their proceedings, and a summary of the principal subjects that have engaged their attention during the past year. They trust that the Members will feel that they have not abated in their zeal for the great cause for which the Society was originally instituted — the

advancement and promotion of astronomy, — but that they have applied their limited means in the most efficient manner, towards forwarding the objects and views of the Society.

(*The President then addressed the meeting on the subject of the award of the Medals, as follows :—*)

GENTLEMEN, — I have now to claim your attention to the subject of our Annual Prizes. In the distribution of such honours there is frequently a difficulty of choice, from the number and strength of competing claims; and the past year has produced matter of much interest to astronomers. The comet of Encke has revisited our sphere, — not, like a forgotten thing, to take us unawares, but as an old, familiar friend, giving due notice of his arrival, and strict to his appointment. Of all the wonders that astronomy has disclosed to us, there is none more astonishing than to see this dim, misty, all-but-incorporeal thing, whose parts can have no more cohesion than the floating particles of the lightest fog, borne along by its inertia, and commanded by its gravity, like the denser planets with which it must henceforth be associated. We look to this comet as the revealer of many secrets, such as whether there exist a ponderable, or at least material ether in the planetary spaces, or any vestige of unabsorbed, nebulous matter in our system, susceptible of being caught up by it, and thus diminishing its speed and retarding its progress.

The list of papers which has been read to you, and which has been stated in the Report of your Council, will prove the zeal and diligence of our British astronomers and our associates; and the same spirit which has now for many years been prevalent on the Continent still animates it, and continues to produce the happiest results. At home we have further to congratulate the astronomical public on the attention that has been drawn to the improvement of the achromatic telescope, whether by the use of different media from the usual ones, or by a different combination of those commonly employed; and on all hands we find no reason to regard astronomical discovery as having relaxed in its progress.

The first Medal which I shall this day have the honour to present, according to the award of your Council, is a Gold Medal to Dr. Pearson, for his book, entitled, " An Introduction to Practical Astronomy;" one of the most important and extensive works on that subject which has ever issued from the press. The treatises existing on theoretical astronomy are numerous and extensive, as befits the dignity and abstruseness of the subject; but works on the practical department, explaining the best methods of observing, and the precautions necessary, condensing and bringing together the tables most compendious or more generally adopted, and describing in detail the various instruments employed, — the manner of using and adjusting them, — and the species of observations for which they are adapted; — such works were altogether wanting, or existed at best in a very insufficient state. We have here, however, the desideratum supplied. Dr. Pearson, in his first volume, has brought

together all the tables which the practical astronomer is ever likely to want. Nor is this a mere compilation. Nearly half the volume consists of new Tables, and the rest are for the most part either extended or improved in their arrangement. The most considerable and striking part of Dr. Pearson's work, however, is the second volume, now just published. This is destined to a description of instruments, and is accompanied with a series of plates, so complete as almost to render description superfluous. It is no small advantage in such a case, to know that the instruments described have been for the most part in the actual possession of their describer, and used by him in actual observation. Such has been the case in this instance.

(*The President then, addressing Dr. Pearson, continued thus:*—)

Dr. Pearson, — You have applied your splendid collection of instruments to a most excellent use. You have not frittered your time away in commencing and breaking off a series of observations with one and with another, at the impulse of the moment; but, by studying their peculiarities, noting down their adjustments, and delineating their forms, you have given a most useful aid to those of less experience than yourself, and have added a value to every instrument you have described, by your labours. In dedicating this second volume of your book to our admirable Troughton, you have raised him a monument which must be peculiarly gratifying to his feelings. In your pages he may see how large a place he occupies in his art, and in the science on which it depends; and we all rejoice that he has lived to receive this applause at your hands. For yourself, sir, be assured, this Society, who know the sacrifices you have made, and the liberality with which you have set at nought all calculations of profit and loss in producing a work of such vast expense and such small probable return, congratulate you heartily on thus bringing your labours to a close, and mark the epoch by presenting you with this Medal.

(*The President then resumed his address to the Members, as follows:*—)

Gentlemen,—The next Medal which has been awarded by your Council is a Gold Medal to Professor Bessel, for his observations of the stars in *zones*, made by him at the Royal Observatory of Königsberg; — a vast undertaking, and one which would alone suffice to confer immortal honour on a name, which has already so many other independent claims to astronomical distinction. The attention of astronomers, in fixed national observatories, up to a late period, was almost exclusively confined to observations of the sun, moon, and planets, and a moderate number of the principal fixed stars. The smaller stars, the minor host of heaven, were systematically neglected, and the conspicuous ones only deemed worthy of being observed in any other than a desultory way. Their utility for the purposes of nautical astronomy might of course be expected to draw upon the most remarkable ones a proportionate attention;

but astronomers, like the vulgar, had been too much influenced by appearances and by glitter, and had fallen into habitual neglect of the rest, or contented themselves with rough approximations to their places, sufficient to mark them down in maps, or include them in lists and approximate catalogues; but inadequate to the determination of any delicate question as to their proper motions, parallax, &c. To this, however, one splendid exception must be made in the Catalogue of Piazzi. This record of the places of more than 7000 stars of all magnitudes, determined with an excellent instrument, with all the care of a diligent and cautious observer, and from several observations of each, is one of the finest monuments of astronomical research. Nor ought the labours of Lalande to be forgotten. His examination, indeed, was extended to an enormous list, to no fewer than 50,000, and was conducted, like Professor Bessel's, in zones. It has been rendered available, also, to astronomers, by tables of reduction, of the simplest possible kind, published by Professor Schumacher, and is indeed a most useful and valuable collection. It labours, however, under the disadvantage of a great inferiority in an instrumental point of view, and therefore can be nowise regarded as superseding or anticipating the more refined inquiries of Professor Bessel.

It would be quite superfluous to speak here of the general merits of Professor Bessel as an astronomer, or of the excellence of the observations regularly made in the observatory under his direction. We know and appretiate them; but they are not to be made the subject of our remarks or our praise on this occasion. The observations for which your Medal is awarded to him were commenced in 1821, and have been continued with little intermission ever since, at the Royal Observatory at Königsberg, with the meridian circle of Reichenbach, having a magnifying power of 106 applied to a most excellent telescope. This instrument being confined to a zone of about two degrees in breadth, is made to oscillate or sweep up and down continually, while the heavens pass in review before the observer by their diurnal motion, and all stars, down to the ninth magnitude, which pass the field, are taken at once in right ascension and declination, and read off by the clock and limb of the circle. This mode of observing presents two capital advantages,—viz. multitude of objects, and facility of reduction. Of the former we may judge by the fact, that in some of the zones we find between three and four hundred objects observed at a sitting: with respect to the latter, a little table, of the simplest use and most compendious form, is attached to each zone, and by its aid the readings of the clock and limb are at once reduced (by a calculation comprised in three lines) to the mean right ascensions and declinations of the objects at a fixed epoch, freed from instrumental error, and ready for the catalogue. Those only, who know by experience the labour of reducing observations not made on this system, can imagine the saving of toil and drudgery thus arising. Nay, more—it renders the observation-book itself available as a catalogue; for, by the system of indexing the zones, any point

in the heavens may at once be referred to, and every object there observed at once reduced, without need to turn over the book, to enter into any inquiry, or in any way refer beyond the page before us and the table of reductions in the beginning of each volume. This is the perfection of astronomical book-keeping.

This course of observations was commenced, as I have already said, in 1821; and you may judge of the industry and perseverance with which it has been prosecuted, by the fact, that, by the end of 1824, the whole equatorial belt, of 30° in breadth, of the heavens, had been swept, and between 30 and 40,000 stars observed. But this did not satisfy the zeal, or exhaust the patience, of M. Bessel. He has since continued the work northward with unabated ardour, and is extending his zones to the 45th degree of northern declination: thus embracing, in the whole, sixty degrees of the finest part of the heavens.

A great many double stars, some of them very delicate ones, have been detected in these sweeps; they are included in M. Struve's splendid catalogue of these objects. Nor is it at all improbable that many new planets may have been seen, and, on a repetition of the observations, will be found missing. In a word, we have, in this collection, one of those great masses of scientific capital laid up as a permanent and accumulating fund, the interest of which will go on increasing with the progress of years. It is a harvest sown, and already springing, but of which the ripened produce is destined for after generations. Yet the crop, if a remote, is a sure one. It will neither be uprooted by political convulsions, nor stinted by neglect, nor spoiled by premature gathering in. The language of such a record is like that of prophecy. It is written, but we cannot yet read it. It is full of truth, but not for us. It contains the statement of a vast system, but future generations must develope it. Could it be permitted us to look forward and draw aside the veil which a few centuries interpose between us and its interpretation, we might expect to see all the great questions which agitate astronomers set at rest, and new ones, more refined, and grounded on their solution, arising. Some minute and telescopic atom will perhaps have become the stepping-stone between our system and the starry firmament — its parallax will mark it for our neighbour — and either its fixity will demonstrate the equilibrium of our immediate sidereal system, or its proper motion reveal to us the nature and extent of the forces which pervade it. The orbits of those remarkable stars which are ascertained to be really *erratic*, or which have a proper motion too large to be overlooked, such as 61 *Cygni* and μ *Cassiopeiæ*, will become known. They will be seen to deviate in their paths from great circles of the heavens — their convexity or concavity will mark the directions, and their changes of velocity the intensities, of the forces which urge them. Already, since the date of the first catalogue of fixed stars, the former of these wonderful objects has moved over no less than four degrees of the heavens. Had it been accurately observed but once in a century, what might we not have known! Let this con-

sideration stimulate astronomers to follow up the splendid example Professor Bessel is setting, and complete and pursue the gigantic task he has carried on so far, but which is beyond the power of any one man to go through, much less to repeat. How much is escaping us! How unworthy is it of those who call themselves philosophers to let these great phenomena of nature — these slow, but majestic, manifestations of the power and glory of God — glide by unnoticed, and drop out of history, beyond the power of recovery, because we will not take the pains to note them in their unobtruding and furtive passage; because we see them in their every-day dress and mark no sudden change; and conclude that all is dead, because we will not look for the signs of life; and that all is uninteresting, because we are not impressed and dazzled.

We must not, however, be hasty in our reproaches. There is a general sense afloat among the continental astronomers, of the necessity of laying a foundation for future sidereal astronomy, as deep and as wide as the visible constituents of the universe itself. Nothing less than ALL will be enough — *quicquid nitet notandum*. To say, indeed, that every individual star in the milky way, to the amount of eight or ten millions, is to have its place determined and its motion watched, would be extravagant; but at least let samples be taken — at least let monographs of parts be made, with powerful telescopes and refined instruments, that we may know what is going on in that abyss of stars, where, at present, imagination wanders without a guide. Let us at least scrutinize the interior of sidereal clusters. Who knows what motions may subsist, what activity may be found to prevail, in those mysterious swarms? Or if we find them to be composed of individuals at rest among themselves — if we are to regard them as quiescent societies of separate and independent suns, bound by no forcible tie like that of gravity, but linked by some more delicate and yet more incomprehensible cause of union and common interest — the wonder is all the greater. We walk among miracles, and the soul yearns with an intense desire to penetrate some portion of those secrets, whose full knowledge, after all, we must refer to a higher state of existence, and an eternity of sublime contemplation.

Another Gold Medal, Gentlemen, has been awarded to M. Schumacher, for the important services rendered by him to both practical and theoretical astronomy by the publication of his various astronomical tables, and of his work entitled *Astronomische Nachrichten*.

Astronomy is a science peculiarly in unison with the German national character. The persevering industry which forms so striking a feature in it, is the quality, of all others, requisite for an astronomer — that diligence which never wearies, and which, working slowly, and destroying nothing that is done,* goes on

* Beschäftigung die nie ermattet, die langsam wirkt doch nie zerstört, &c. — *Schiller.*

adding grain by grain to the mass of results, and accumulating them with a kind of avarice to swell the heap;—that pains-taking scrutiny which penetrates through all details, and will not be satisfied till perfection is attained. And, on the other hand, an enthusiasm seemingly incompatible with this plodding turn, yet often co-existing with it in the same mind; a love of systems for their own sake; a spirit of speculation, sometimes bordering on wildness; and an ardent inherent love of the vast and wonderful. Among minds of this turn it is no wonder that astronomy should flourish—with enough of sublimity and mystery to exhaust the wildest imagination, and enough of laborious detail to keep in employment the most patient industry. Accordingly, Germany has always been fruitful in astronomers, and (regarding as Germans all who are bound in the common family tie of language and manners) German astronomy has at present reached a pitch of eminence, which only national pride prevents our acknowledging to be unexampled in the history of the science—whether we consider the researches of their theorists, the activity of their computers, or the number and importance of their national observatories: or those of Russia, several of which are manned (so to speak) with directors and assistants who have been educated in the German school, and transplanted from German observatories, and from the personal tuition of their most illustrious men, who have worked with them as their friends and pupils, rather than as mere assistants, and who look up to them with the veneration of the scholar to his master.

Among all these, and among those numerous and talented individuals throughout the continent, and in England, who are attached to astronomy professionally, or from love of the science, the *Astronomische Nachrichten* of Professor Schumacher establishes a point of concourse—a complete bond of union: we have there a theatre of discussion of whatever is most new and refined in the theory and practice of astronomy—the utmost delicacies of computation and scrupulous investigation of instrumental errors are given by those most competent to supply and to judge of them. To its pages observations of every kind find their way, especially those which depend for their utility on corresponding observations, or which lose their interest and importance by long suppression. Not a comet appears but *there* we find its elements handed in from all quarters with emulous rapidity—occultations—moon culminating observations—computations of longitudes and latitudes—disquisitions on practical points—descriptions, advertisements, and prices of instruments—in a word, every thing which can awaken and keep alive attention to the science—every thing that can facilitate the contact of mind with mind. Every one who has attended to the progress of knowledge in recent times, must feel all the importance of such an engine. But it cannot be kept in action without a strong presiding power. In any inferior hand it would languish, and soon fall into disrepute and inaction. Professor Schumacher is, of all men, that one whom the voice of Europe would have fixed on for the conduct of such a work: an excellent astronomer himself, and

presiding over an observatory in which every thing is delicate and exquisite, he possesses that practical and theoretical knowledge which commands respect, and gives his acceptance or rejection of contributions a weight from which there is no appeal. He has, moreover, the eminent but merited good fortune to possess the full and effective support of a Government deeply impressed with the importance of astronomical science. With this powerful aid, which would have been accorded to no other, he has been enabled to establish sure and regular communications with every part of the civilized world — and to face an expenditure which, under similar circumstances, no private individual would have ventured to undertake. He has thrown his whole weight into the scale of advancing science; and the effect has been, the establishment of a great European astronomical republic, with a common feeling, and a sense of common interests.

But the services rendered by M. Schumacher to astronomy are not limited to this publication. A numerous and useful collection of tables has been edited by him, under the title of *Hülfstafeln*, or assistant tables, and others. One of these volumes is devoted to facilitate the reduction of the observations of Lalande in the *Histoire Céleste*, on the same plan with those used for the reduction of Bessel's zones. This truly useful work rescues from oblivion the labours of Lalande, and renders his observations available to science. M. Schumacher, liberally assisted, in a pecuniary point of view, by the Royal Danish Hydrographic Office, has also followed up the example set by the Coimbra Ephemeris, of the publication of lunar distances from the planets, — thus rendering available a new branch of nautical astronomy, and hastening the period when observations of the planets at sea would have naturally been called for.

In the computation of the assistant tables, M. Schumacher has had most active assistance from several accomplished Danes; of whom I may mention Hansen, Clausen, Ursin, Nissen, Nehus, Zahrtmann, and Petersen. In honouring the principal, we honour the accessaries; and we trust that the tribute of this passing notice will not be displeasing to them and their coadjutors.

Captain Smyth, — As you are kind enough to act as proxy for Professors Bessel and Schumacher, receive for them these their respective Medals; and, in transmitting them, take care to convey to them the expression of our gratitude and admiration for the services they have rendered to our science, and our wishes that their brilliant and useful career may be prolonged yet many years, with increase of glory, and with health and prosperity to enjoy it.

List of Officers for the ensuing year.

President: James South, Esq. F.R.S. L. & E. M.R.I.A. & F.L.S.—*Vice-Presidents:* Francis Baily, Esq. F.R.S. L.S. & G.S. & M.R.I.A.; Captain F. Beaufort, R.N. F.R.S.; Davies Gilbert, Esq. M.P. *Pres.* R.S. F.L.S. & G.S.; Olinthus G. Gregory, LL.D. *Prof. Math. Roy. Mil. Acad. Woolwich.*— *Treasurer:* Rev. William Pearson, LL.D. & F.R.S.—*Secretaries:* Rev. Richard Sheepshanks, M.A.; Lieutenant William S. Stratford, R.N.—*Foreign Secretary:* Captain W. H. Smyth, R.N. F.R.S. & A.S.—*Council:* Right Hon. Lord Ashley, M.P.; Captain Everest, F.R.S.; Benjamin Gompertz, Esq. F.R.S.; J. F. W. Herschel, Esq. M.A. V.P.R.S. F.R.S.E. F.G.S. & M.R.I.A.; Rev. Dionysius Lardner, LL.D. F.R.S. & M.R.I.A.; John Lee, Esq. LL.D.; John William Lubbock, Esq. M.A.; Edward Riddle, Esq.; Edward Troughton, Esq. F.R.S. L. & E.; John Wrottesley, Esq. M.A.

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

March 13, 1829. No. 18.

A PAPER was read, " On the errors likely to arise in the determination of the length of the pendulum, from a false position of the fixed axes." By Captain Everest, Member of the Society.

Pendulums having been lately constructed for the Honourable the East India Company, to be used in their presidencies of Bengal and Bombay, the Court of Directors expressed a desire that Captain Everest should explain their nature and use to the gentlemen cadets at Addiscombe: he was thus led to consider with minuteness the different errors which might be supposed likely to affect the accuracy of the experiment, in the full expectation that they would be found, as has always been supposed, wholly insignificant. The result of these investigations has, however, not corresponded with his expectations.

Captain Everest supposes the bar, of which the pendulum is composed, to be a rectangular prism, suspended at one extremity by a line, inflexible and void of weight, as its axis. This axis ought to be perpendicular both to the length and breadth of the bar, and is so placed by the artist to the best of his ability. It is, however, evident that the axis may deviate from this position in two ways:— 1st, It may not be at right angles with the breadth of the bar; and 2dly, It may not be so with regard to the length.

In the first hypothesis Captain Everest ascertains the length of the isochronous simple pendulum, and finds that it is shorter than it would be if the axis of suspension were perpendicular to the breadth, by a quantity depending upon the dimensions of the rectangular bar, and the angle by which the axis may be conceived to be displaced or *twisted* from its proper position. Reducing his formula into numbers for the pendulums made by Mr. Jones, of Charing Cross, and also for Mr. Baily's pendulum, he finds that, if the twisting of the axis be supposed $= 1° 45'$, the pendulum would, in either instance, be shortened 0·00001 inches very nearly; and that if the error be supposed $= 0° 33'$, this quantity would not exceed 0·000001 inches; from which he concludes, that we may safely neglect any error likely to arise from this cause.

In the second hypothesis, that is, when the axis is not at right angles to the length of the pendulum, but deviates from this position by a given angle (x), Captain Everest finds the following diminution of the apparent length of the isochronous simple pendulum l:—

Values of δl in Inches.	Values of the deviation x.	
	Mr. Jones's Pendulum.	Mr. Baily's Pendulum.
0·1	4° 5′	4° 3′
0·01	1 18	1 16
0·001	0 24½	0 24
0·0001	0 7¾	0 7⅔
0·00001	0 2½	0 2½

Whence he concludes, that a much more serious error would be likely to arise from this source than from that first considered, and proceeds to shew that when a convertible bar pendulum is used for determining the length of the simple seconds pendulum, as in the experiments mentioned by Mr. Baily (*Phil. Mag.* Feb. 1829), there are concomitant causes which still further increase this error.

One of the axes in Mr. Baily's pendulum is placed as nearly as is practicable at the end of the bar, and the other axis at a distance from the former of about $\frac{2}{3}$ the whole length. These axes are made *convertible* by experiment; and if they be both perpendicular to the length of the bar, the distance between them will give the true length of the isochronous simple pendulum. Now, suppose the upper axis to be inclined,—the time of vibration will be diminished; and therefore, *to preserve the condition of convertibility*, we must suppose the reciprocal axis, which remains perpendicular, to be so shifted as to diminish the time of vibration by an equal quantity. It will easily be seen that this can only be done by removing it farther from the centre of gravity, and therefore from the upper axis; and thus, not only will the time of vibration be diminished, but the apparent length of the pendulum (being the distance measured between convertible axes) will be increased. If, then, the length of the simple pendulum vibrating seconds be deduced from a pair of knife-edges thus placed, it is clear that a value in excess will be obtained.

Again, suppose both axes inclined, and parallel to each other, the apparent or measured length of the pendulum will exceed the true length, which in this case is the *perpendicular* distance between the axes. Captain E., however, finds that this error is less than on the supposition made above. But if the extreme axis be now supposed perpendicular, the time of vibration about it will be increased, therefore the reciprocal axis (still supposed inclined at the original angle) must be so shifted as to increase the time of vibration, in order *to preserve the condition of convertibility*. This can only be effected by bringing it nearer to the centre of gravity, and thus shortening the apparent length of the pendulum. If the length of

the simple pendulum were determined from a pair of knife-edges thus placed, it appears that the value would be in defect; and Captain E. finds "that the apparent length exceeds the true length in the first hypothesis by three times as much as the true length exceeds the apparent length in the last hypothesis, the angle of deviation being in both cases the same."

He then proceeds to consider the discrepancies observed by Mr. Baily, upon the following suppositions, viz. — that the first extreme axis is inclined while its reciprocal is perpendicular to the bar, and that the second extreme axis is perpendicular while its reciprocal is inclined at the same angle as the first extreme axis; when he finds that an inclination of 0° 49′ would reduce both measures to the same length, and concludes as follows: — "However opinions may differ respecting my success in clearing up the discordancies alluded to by Mr. Baily, few are there, perhaps, but will regret that, previous to the introduction of the knife-edge into general practice, some mode of adjustment had not been devised, or some steps taken to inquire into the nature and effects of deviations, such as all instruments must be liable to. Doubtless, it would have been more masterly had the above investigation taken a wider range, and applied to the general case of any two deviations, x and y, and axes any how posited, provided they were synchronous. It is imperfect, too, in as far as the knife-edges themselves are not taken into consideration; but it is plain, that if, without these minutiæ, no sensible effect is produced, none will arise from their influence alone. It will be time enough to furnish formulæ of correction when we have the means of detecting our errors. Let some ingenious person devise the method of affecting the angle which the line passing through the centre of gravity makes with the axis; and if no abler person offers to undertake the task, I will willingly resume my labours."

A paper was then read from James Prinsep, Esq., assay-master of the mint at Benares, containing the observation of a solar eclipse on the 13th and 14th of April, 1828, at Benares, with an account of the instrument, and the periods of the eclipse as obtained by construction. Mr. P. observed the transits of the limbs of the sun and of the cusps over the wire of an equatorial telescope.

"During the whole of the eclipse the atmosphere was unclouded, but, notwithstanding that barely the twentieth of the solar disc was at one time visible, the diminution of light was not such as to strike an inadvertent observer; the shadows of objects were fainter, but well defined, and the eye could not attempt to view the sun undefended; a thermometer placed in the sunshine on the equatorial fell from 110° to 95° in the interval between 4^h and $4^h\ 40^m$ P.M.; it rose again as high as 99° before sunset. Captain Herbert found at Almorab, by a photometer of his own contrivance, that the light was just equal to that of a cloudy day."

The next paper read consisted of Observations made at the Calton Hill Observatory, Edinburgh, (lat. 55° 57′ 20″ N.; long. $12^m\ 44^s$ west of Greenwich): — 1st, Of transits of the moon and

moon-culminating stars, in 1828, by Mr. Thomas Henderson; 2d, Of occultations of stars by the moon, by Mr. John Adie. The longitude of Edinburgh west of Greenwich, computed by Mr. Henderson, from eleven corresponding observations of the first limb and three of the second limb, is $12^m\ 40^s,55$.

A paper was also read, containing the places of Encke's comet, as reduced from thirty observations made by Mr. Dunlop, between October 26 and December 25, 1828, at Sir Thomas Brisbane's Observatory, Makerstoun, Roxburghshire.

There was, lastly, read a paper "On preserving the pivots of astronomical instruments;" by Lieutenant Peter Lecount, R.N. As the pivots of astronomical instruments are generally of steel, working in brass sockets, and are of necessity kept oiled, it would seem that when the oil becomes acid the galvanic arrangement is formed, and the steel pivot is decomposed and not the brass. Mr. L. therefore recommends that the pivots and sockets should be of the same metal, or, if this be inconvenient, that the pivots should be cleaned and fresh oil applied before acidity occurs, especially in the transit instrument.

Copy of the Regulations of the Council, relative to the Instruments of the Society, alluded to in the Annual Report, Feb. 13, 1829.

1. THAT a book be kept, to be called the Instrument Book, in which shall be inserted a full and particular description of every instrument that may belong to the Society, with an inventory of its several parts; together with the date when it was presented to the Society, and the name of the donor, as well as such other memoranda relative to the same as may be considered expedient.
2. That on every instrument belonging to the Society, and on their several parts, a sufficient mark, inscription, or number, be engraved, (and in the particular case of object-glasses, written with a diamond), for the purpose of identifying the same.
3. That when any instrument has been presented or left to the Society, such presentation or bequest shall be announced at the next ordinary meeting; and the instrument shall not be lent to any person till after one month from such announcement.
4. That when any person is desirous of borrowing an instrument of the Society, he shall state (in writing) to the Council such his desire, and the object he has in view: and no instrument shall be lent but on such written application.
5. That no instrument whatever shall at any time be lent for a longer period than three years; and that at the end of that term it shall be returned to the Society, unless the Council shall be of opinion that it would be expedient to extend the loan for another period, when they shall be at liberty so to do.
6. That all expense of moving and transporting an instrument from and to the Society be defrayed by the borrower, unless the Council shall otherwise direct at the time.
7. That the borrower of any instrument be requested to communicate to the Society, from time to time, the observations that he may make with the same.
8. That no borrower be allowed to make any alteration in an instrument, or any of its parts, without leave of the Council.
9. That no instrument shall be taken out of the country without special leave of the Council.
10. That every borrower shall sign a written engagement to return the instrument to the Society in as good a state as he received it (fair wear and tear excepted), in conformity with the 5th Regulation; and also to abide by these Regulations, as far as he is concerned.

J. NOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

April 10, 1829. No. 19.

A PAPER was read, entitled " A catalogue of 195 double stars, taken from the *Histoire Céleste*, and reduced to Jan. 1, 1800;" by M. Berencer Labaume, of Marseilles.

M. Labaume commenced, some years ago, the reduction of the *Histoire Céleste*, and a part of the reduced catalogue was published by Baron Zach in his *Correspondance Astronomique*, vol. vii. &c. This labour M. Labaume has been compelled to suspend; but he had already computed the present list of double stars, which has not yet been published. The magnitudes, right ascensions, and declinations of the stars are given; and, when both stars have been observed, the place of each. M. Labaume has added the date of the observation, in case any proper motion should be detected.

A paper was also read, " On observing the eclipses of Jupiter's satellites at sea;" by Lieutenant Peter Lecount, R.N.

Mr. Lecount conceives that the observation of the eclipses of Jupiter's satellites at sea has been prevented in a great measure by Dr. Maskelyne's remarks on that subject in the *Nautical Almanac*, and the high respect which seamen naturally pay to such distinguished authority. From his own experience, however, confirmed by that of his brother-officers, Mr. Lecount asserts, that in moderate weather these phenomena can be observed by any one who has been accustomed to use a telescope at sea, and that the three-feet glasses, with a power of about 45, in common use on board men-of-war, are the most proper for the purpose.

As it is very troublesome to follow the satellite when the ship has much motion, Mr. L. recommends the observer to limit his attention to the times when the vessel is at the extremity of her roll or pitch. An attendant with a watch should be at hand to note the times when the observer is *certain that he does see* the satellite, previous to immersion, and *certain that he does not see* it, after immersion, the mean of which is to be taken for the true time. A similar method must be adopted for emersions. With common care, Mr. L. thinks that these observations should give the longitude within 15 or 20 miles; and those made by himself on board the Conqueror 74, for six months at St. Helena, and during the passage home, came much nearer to the truth.

The next paper read contained astronomical observations made at the Observatory of the Imperial University of Wilna, by Professor Slawinski, in the year 1828.

These observations are of Jupiter, Mars, and Uranus, at opposition, and of Mars at quadrature.

Fourteen observations of Jupiter about opposition, compared with Bouvard's tables, give

	Long.	N. Lat.
Mean error of the tables.....	+ 8″,4	− 2″,6
Greatest difference from the mean..	3 ,5	7 ,0

The stars with which Jupiter was compared are, Nos. 1624 and 1677 of the Society's Catalogue, and the mean places and corrections of these stars, and of those mentioned hereafter, are computed from that work. The place of the earth is computed by Delambre's tables.

Seven observations of Mars, about opposition, compared with Lindenau's tables, give

	Long.	S. Lat.
Mean error of tables	− 8″,7	+ 6″,1
Greatest difference from the mean..	2 ,7	2 ,9

Stars of comparison, 2163, 2208, Ast. Soc. Cat.

Four observations of Mars about quadrature, compared with Lindenau's tables, give

	Long.	S. Lat.
Mean error of tables	− 34″,5	− 0″,5
Greatest difference from the mean .	4 ,7	2 ,2

Stars of comparison, 2484, 2501, 2520, 2566, Ast. Soc. Cat.

Four observations of Uranus about opposition, compared with Bouvard's tables, give

	Long.	S. Lat.
Mean error of tables	+ 12″,1	+ 12″,8
Greatest difference from the mean..	2 ,0	4 ,3

Stars of comparison, 2313, 2497, Ast. Soc. Cat.

Lastly, there was read a portion of a paper by Mr. Sheepshanks, to explain the method of interpolation given by Da Rocha, and employed by him in computing and correcting places of the moon in the Ephemerides of Coimbra, and on the further application of this method to astronomical computations. An abstract of this paper will be given hereafter.

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

May 8, 1829. No. 20.

A PAPER was read from Mr. Rumker, containing observations made at Paramatta.

1. Twenty-one observations of the south polar distance of the sun about the northern solstice 1827.

2. Twenty observations of the south polar distance of the sun about the southern solstice 1827. These are reduced, and the resulting mean obliquity stated to be 23° 27′ 43″,16, Jan. 1, 1828.

3. Nineteen observations of the south polar distance of the sun about the autumnal equinox 1827.

The index error or south polar point of the mural circle with which these observations were made, was ascertained by numerous observations of stars above and below the pole near the times of solstice and equinox, and also by comparing the observed places of several standard stars with their apparent places in the *Nautical Almanac*.

All the observations of the sun and stars are given with the corrections and reductions, the index error as determined from each star and from a mean of all the stars, and a catalogue of the south polar distances of nineteen principal south circumpolar stars.

The observed semi-diameter of the sun appears to be too large from these observations, which agrees with what others have found it in the meridian.

The mean right ascension of β Crucis and α^2 Centauri, Jan. 1, 1828, deduced from a direct comparison with the sun at the foregoing autumnal equinox:—

Mean R.A. β Crucis	129°	26′	1″,074
——— α^2 Centauri	216	59	59,674

β Crucis has been preferred to α Crucis, because the latter is double, and very much resembles Castor in the magnitudes and distance of the component stars.

The method pursued by Mr. Rumker for obtaining the R.A. of β Crucis and α^2 Centauri is as follows:—Let δ be the observed declination of the sun, ω the obliquity of the ecliptic, and α the distance of the sun from the equinox given by the equation—$\sin \alpha = \cot \omega \times \sin \delta$; then, as ω may be considered as known with great exactness, the error in α will depend entirely upon the error in δ. Any other observed declination, δ', will also afford a corresponding value of the sun's R.A., or α'; and subtracting or

adding α and α', we shall have the increase of the sun's R.A. between the two epochs. Now, the increase may be independently obtained, and with great exactness, either by *observation* (where it is only necessary to determine the clock error by the *same* stars each day, or by stars whose *differences* in R.A. are well known,) or from the *Nautical Almanac*. If a be the error in R.A. corresponding to 1″ in declination about the time of equinox, m the error in the value of $(\alpha \mp \alpha')$ ascertained by the preceding methods, v and x the unknown errors in δ and δ', then $a \times (v + x) = m$. Similarly, if α'' be the R.A. corresponding to a declination δ'', and y and n the errors in δ'', and $(\alpha \mp \alpha'')$, $-a \times (v + y) = n$; and so on. And if care be taken to observe the upper and lower limbs alternately, so as to eliminate all constant error, it is clear that the sum of $x + y + v$ will be very small, and, therefore, that v will be determined with great accuracy. It is in this manner that Mr. Rumker has corrected each declination of the sun by a comparison with all the rest, and this corrected declination is used for obtaining the sun's distance from the equinox at apparent noon. Tables are given of the true values of $\alpha \mp \alpha'$, &c., as determined by observations and by the *Nautical Almanac*.

The time of apparent noon or midnight, and the transits of β Crucis and α^2 Centauri, are concluded from equal altitudes; and as the sun's R.A. at those times is already known, the R.A. of each star is obtained independently of any previous catalogue.

The original observations of equal altitudes will be sent. Mr. Rumker was desirous of having accurate and independent places of certain circumpolar stars, and seems to have been induced to adopt this method of equal altitudes, in preference to observations with the transit instrument, from the following consideration:— A transit instrument, pointing to any given north zenith distance, rests precisely upon the same points and in the same manner as when pointing to an equal south zenith distance *after reversion*, when the pivots are equal, the line of collimation adjusted by a horizontal object, and the level correct before and after reversion. Suppose that, from any flexure of the telescope or bending of the axis, the instrument has a deviation from the meridian,—for instance, to the east of the north,—then *after reversion* the deviation would be to the *west* when pointed south, and thus the twisting would shew itself as an error of azimuth, and be corrected as such; but if, as is the case in practice, the instrument were *not* reversed, then the deviation, when pointed south, would be to the east of the south, and thus the flexure would shew itself as an error of *collimation*, while, as that is supposed to be nothing, it would be treated as an error of azimuth.

The accuracy, therefore, with which we can compare the transits of stars near the pole with the sun or stars near the equator, can only be judged of by comparing transits of stars near the pole in one position of the instrument with those of the same stars after reversion. "These defects in the transit at Paramatta," Mr. Rumker adds, "are partly compensated by being enabled, from

its optical power, to observe the returns to the meridian of small stars near the pole by day-time. I have, nevertheless, deemed it expedient to insure the correctness of the right ascensions thus determined, by laying down, independently thereof, the position of fixed stars in different zones, so that other stars in the same parallel may be determined with a transit in a less perfect state."

4. Differences of the transits of the moon and moon-culminating stars, observed at Stargard and Paramatta between October 1825 and July 1826.

There was next communicated " A catalogue of upwards of 500 stars observed by Flamsteed, but not inserted in the British Catalogue; together with some remarks on Flamsteed's observations;" by F. Baily, Esq. This paper may, in some measure, be considered as a continuation of a former paper communicated by the author about two years ago, an abstract of which was given in No. 5 of these monthly notices. It is well known that we are indebted to Miss Caroline Herschel for this list of Flamsteed's inedited stars; who, by a laborious examination of every observation of every star, has discovered a great many that have never yet been reduced. Miss Herschel, however, has merely indicated the page and line of Flamsteed's observations, where the star is to be found, without any regard to the arrangement in right ascension, which did not enter into her plan; and it was, consequently, oftentimes very troublesome and inconvenient to ascertain even in what part of the heavens such stars were situated, when a reference was required to be made to them. Mr. Baily, therefore, has undertaken and completed the task of reducing all these observations to one common epoch, viz. the beginning of the year 1690, which is the epoch of Flamsteed's catalogue, whereby a convenient and easy reference may, at any time, be made to any star required. These places, however, it should be observed, are not given with any greater accuracy than the positions of the stars in Flamsteed's catalogue: since they are deduced merely by taking the differences in right ascension and declination between such stars, and certain known stars in their neighbourhood, observed on the same nights. A complete revision and reduction of Flamsteed's observations is still considered a desideratum by Mr. Baily; and which he hopes, at some future time, to see, if not wholly, at least in part, accomplished, by a reduction of some of the most important stars. When Miss Herschel published her list of these inedited stars, the catalogues of Bradley and Piazzi, and the voluminous observations of Lalande, had not been made public, and she was, consequently, unable to identify many of the stars in question: but, by a minute examination and comparison of these works, Mr. Baily has identified nearly all the stars which are given in Miss Herschel's list. Such as still remain undetermined are either those that have considerable north declination, and, consequently, situated in a part of the heavens which has not been much examined, or are such as have been but imperfectly observed by Flamsteed. In those cases where the star has been sufficiently identified, the synonyme is given by

Mr. Baily in a collateral column; and at the end of the catalogue are inserted some *notes* relative to such other stars whose positions are somewhat doubtful.

[The publication of the Second Part of the Third Volume of the Society's Memoirs was announced.]

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

June 12, 1829. No. 21.

THE following communications were read, viz.—

1. On the convertible pendulum; by Benjamin Gompertz, Esq., in a letter to Francis Baily, Esq.

The remarkable anomalies which offered themselves to Mr. Baily, in his researches upon the length of the seconds pendulum, induced him to propose the general problem to the consideration of Mr. Gompertz, some time before the presentation of Captain Everest's paper upon the same subject. It will be seen that these two gentlemen have treated the subject in very different ways, although arriving at the same conclusion; viz. that very serious errors may arise from a faulty placing of the knife-edges, and that the results to be obtained from the convertible pendulum are less certain than has been hitherto supposed, unless the knife-edges can be fixed with considerable accuracy in a given position, or the deviation from that position be capable of measurement.

The well-known theorem upon which Captain Kater has founded his beautiful method of investigating the length of the pendulum, viz. the reciprocity of the centres of suspension and oscillation, requires, as is seen from the demonstration, that the axes on which the pendulum vibrates should be parallel,—a condition not very readily obtained. When, however, these axes or knife-edges are parallel, and the oscillations isochronous, the resulting length of the pendulum (the corrections for arc, buoyancy, &c. being made,) is the sum of the perpendiculars let fall from the centre of gravity upon each of the knife-edges. This sum will equal the measured distance of the knife-edges when the following conditions are fulfilled:—1st, When the plane determined by the knife-edges passes through the centre of gravity; 2nd, When the measured line is perpendicular to the knife-edges.

If these conditions be not fulfilled, the result of the experiment will necessarily be erroneous; but if the nature and magnitude of the errors committed in placing the knife-edges can be ascertained, the corresponding error in the estimated length of the pendulum may be corrected by calculation.

Let it be supposed that the experiment has been performed,—that the axes are convertible,—the distance between the knife-edges measured, and the time of an oscillation determined after applying the corrections for [illegible] Also let

λ = the true length of the equivalent simple pendulum;

h = the perpendicular from the centre of gravity upon the upper knife-edge;

k = ——————————————————— lower ——————;

M = sum of each particle × distance from an axis through centre of gravity parallel to upper knife-edge × $\frac{1}{\text{Pendulous body}}$;

M′ or M − α = Ditto to lower knife-edge × $\frac{1}{\text{Pendulous body}}$;

l = the measured distance between the knife-edges; then

$$\lambda = h + \frac{M}{h} = k + \frac{M - \alpha}{k};$$

therefore, substituting in the second equation the value of M taken from the first,

$$\lambda = k + \frac{h\lambda - h^2 - \alpha}{k}, \text{ and } \lambda = \frac{h^2 - k^2 + \alpha}{h - k} = h + k + \frac{\alpha}{h - k}.$$

It will be easy to find the difference between $h + k$ and l, if the position of the knife-edges be given, as h and k are known approximately.

Let $h + k = l - n$; then $\lambda = l - n + \frac{\alpha}{h - k}$, where $h - k$ is also known with sufficient exactness.

Mr. Gompertz then shews how the small correction α, which he calls the dynamical correction, is to be obtained; but this portion of the paper does not admit of elementary explanation.

In a pendulum 60 inches long, 2 inches wide, and 1 inch thick, Mr. Gompertz shews that a mistake of $\frac{1}{\sqrt{6}}$ of an inch in the length of the pendulum might arise from errors of 1° in fixing the knife-edges.

2. Original observations of a small comet at Paramatta, (longitude $10^h\ 4^m\ 7^s$ east of Greenwich) by Mr. Dunlop.

The comet was compared in R.A. and declination, with neighbouring stars, by means of a micrometer made by Mr. Dunlop. The journeyman employed was compared with a sidereal clock, whose rate and error were obtained by equal altitudes of the sun, taken with a sextant and artificial horizon. The error of the clock, the comparison with the journeyman, and the value of the revolutions and divisions of the micrometer, are all given; the stars of comparison are identified. This comet appears to be one of a short period.

Another comet was observed about the same time, but the complete observations are not at present in Mr. Dunlop's possession.

3. An extract of a letter to Mr. Herschel from Dr. Olbers, with the R.A. and declinations of Encke's comet, observed by him at Bremen.

Dr. Olbers could perceive no tail. He conceives this comet to have established two important points: — 1st. That it has no light of its own, but shines only by the reflection of that of the sun; 2nd. That it does actually suffer a resistance in that part of space in which it moves. The ephemeris of it, calculated by Encke on the hypothesis of such resistance, indicates only a small and nearly constant error, giving the R.A.'s about 2′ or 3′, and the declinations *1′, too small;* while that of Damoiseau, who supposes no resistance,

gives a very variable error, which, after the middle of November, is very large.

4. Occultations and solar eclipses observed at Palermo, from 1794 to 1819, communicated by Colonel Visconti.

The observations are chiefly made by Piazzi and Cacciatore, and are given in Palermo mean time. The political disturbances of 1820 deranged the observatory so entirely that the solar eclipse of September 7 (which was annular at Palermo) could not be observed, and no observations were made there for some time afterwards.

5. Occultation of Jupiter at Port Famine, Straits of Magellan, in a letter from Capt. King, R.N. to Charles Stokes, Esq.

Lat. 53° 38′ 20,7″ South. Approx. Long. 70° 56′ 4″ West.

May 26, 1828.	Time by Chronometer. h.	m.	s.
Disappearance of 3rd satellite behind ☾'s dark limb	16	21	10,5
Disappearance of 2nd	16	26	28,2
♃'s western limb in contact	16	31	19,2
Disappearance of 1st satellite	16	37	52,3
When ♃ appeared to be the most eclipsed, a very minute portion was visible between two elevations at the moon's "new" disc	16	42	26,0
Re-appearance of the 2nd satellite much beyond the disc	16	45	25,0
♃'s eastern limb in contact with ☾'s disc	16	51	51,0

The disappearance and re-appearance of the 4th satellite, and the re-appearance of the 1st and 3rd, were obscured by mist.

The observations were made on shore with a two feet reflecting telescope, by Thomas Jones, using the highest power of the eye-tube, and largest of the small specula.

The chronometer was $6^h\ 9^m\ 53^s,1$ fast on apparent time.

6. A letter from Professor Bessel to Capt. Smyth, Foreign Secretary.

After acknowledging the receipt of the Society's gold medal, presented at the last anniversary, Professor Bessel says: "I may mention that the zones are at present brought to their 467th number, and that by far the greatest part of the heavens, from 15° to 45° north declination, is filled up. I should have made still further progress but for the unfavourable weather last winter. I was in hopes of extending these observations, in the course of the present year, over the remaining parts between 15° and 45°; but now a year more will be requisite. As soon as I have completed my present task, I shall have the honour of communicating it to the Astronomical Society. The Celestial Charts, which are intimately connected with these observations, are advancing; five hours are nearly or wholly ready for publication."

7. The remainder of a paper by Mr. Sheepshanks, upon the application of Da Rocha's method of interpolation.

The publication of this paper is postponed, as the author has not had time to complete some calculations which should accompany it.

J. NOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

November 13, 1829. No. 22.

THE following communications were read:—

1st. A List of the Occultations of Aldebaran by the Moon, in the year 1830, computed, for ten different Observatories in Europe, by Thomas Henderson, Esq. and Thomas Maclear, Esq., at the request of the Council.

1830.	PLACE.	IMMERSIONS.			EMERSIONS.		
		Sidereal time.	Mean solar time.	Angle.	Sidereal time.	Mean solar time.	Angle.
		h m	h m	deg.	h m	h m	deg.
Jan. 5	Konigsberg	12 3	17 2	346	below	the	horizon.
	Milan	11 26	16 25	327	below	the	horizon.
	Paris	10 56	15 55	328	11 47	16 46	117
	Greenwich.	10 44	15 43	331	11 34	16 33	113
	Bedford ..	10 42	15 41	332	11 32	16 31	110
	Edinburgh.	10 27	15 26	336	11 16	16 15	100
	Dublin ...	10 16	15 16	330	11 8	16 7	110
March 1	Naples ...	0 56	2 20	310	1 13	2 38	341
May 22	Milan	11 35	7 35	348	below	the	horizon.
	Paris	11 6	7 7	351	11 47	7 47	96
	Greenwich.	10 56	6 57	356	11 34	7 34	89
	Bedford ..	10 54	6 54	356	11 31	7 31	87
	Edinburgh.	10 42	6 42	4	11 13	7 13	75
	Dublin ...	10 28	6 29	355	11 7	7 8	88
July 16	Konigsberg	..	..	a near	appulse.	..	..
	Vienna ...	8 51	1 15	1	9 35	2 0	96
	Naples ...	8 43	1 7	343	9 42	2 6	130
	Milan	8 16	0 40	349	9 12	1 36	114
	Paris	7 41	0 6	352	8 34	0 59	103
	Greenwich.	7 30	23 55	356	8 17	0 42	90
	Bedford ..	7 29	23 54	358	8 14	0 39	87
	Edinburgh.	7 20	23 45	13	7 47	0 12	63
	Dublin ...	6 59	23 24	358	7 43	0 7	82

1830.	PLACE.	IMMERSIONS.			EMERSIONS.		
		Sidereal time.	Mean solar time.	Angle.	Sidereal time.	Mean solar time.	Angle.
		h m	h m	deg.	h m	h m	deg.
Oct. 5	Vienna ...	8 58	20 0	36	9 12	20 14	63
	Naples ...	8 38	19 40	2	9 28	20 30	111
	Milan	8 14	19 16	11	8 55	19 57	92
	Paris	7 43	18 46	19	8 14	19 16	76
	Greenwich.	..	..	a near	appulse.	..	..
Nov. 29	Dorpat ...	10 4	17 30	11	10 30	17 56	68
	Konigsberg	9 36	17 2	355	10 17	17 42	90
	Vienna ...	9 20	16 46	339	10 13	17 39	118
	Naples ...	9 18	16 44	325	10 14	17 40	148
	Milan	8 50	16 16	330	9 48	17 14	135
	Paris	8 15	15 41	332	9 14	16 40	126
	Greenwich.	8 2	15 28	335	8 59	16 25	116
	Bedford ..	8 0	15 26	336	8 56	16 22	114
	Edinburgh.	7 45	15 11	342	8 37	16 2	99
	Dublin ...	7 30	14 56	335	8 27	15 53	110

In the preceding ephemeris, the column marked *Angle* denotes the point of the moon's limb where the phenomenon will take place, reckoning from the vertex, or highest point of the moon's limb, towards the west, or right hand, round the circumference.

The object of the Council, in procuring these computations, has been to induce astronomers to look out for the occultations, with a view principally to determine whether Aldebaran will *appear projected on the face of the moon*, as has frequently been observed in former occultations of this star. It is therefore requested, that particular attention be paid to the following circumstances: viz. 1. whether the star undergoes any change of light, of colour, or of motion, on its immediate approach to the edge of the moon; 2. whether it appears to be projected on the moon's disc, and for how long a time; 3. whether the dark limb of the moon be distinctly visible and well defined at the time of the phenomenon; 4. whether the star, on its emersion, appears on the moon's disc, or emerges quite clear of the moon's border.

In recording the observations, it is desirable that the observer should describe the telescope made use of, and that the same instrument should be employed in observing both the immersion and emersion; that it should be noted whether the telescope was adjusted to the moon or to the star, and whether it had been altered during the observations. And as it is probable that the phenomenon may differ in some slight particulars, even to persons observing together in the same place, it is hoped that the actual appearances will be

recorded (as they may present themselves) by each person, without suffering his impression to be biassed by the opinion or representation of others.

It is further requested, that, in recording such observations as may be made, the *correct* time (as well as the place) of observation may be given; that is, the time shewn by the clock *corrected* for its *error*, in order that comparisons may be made of the best mode of computing occultations. Two different methods have been pursued in computing the ephemeris here given; and although the results have agreed sufficiently near to enable the Council to ascertain the time to the nearest minute, yet in some of the cases the results have varied from each other much more than might have been expected. The computations will probably be revised and investigated, when the correct time and place are ascertained.

2nd. Numerous observations of the Occultations of Aldebaran on the 21st of August and on the 15th of October, 1829, of which the following are brief abstracts, arranged alphabetically:—

I. OCCULTATION ON THE 21ST OF AUGUST, 1829.

BEDFORD—CAPT. SMYTH'S OBSERVATORY.

Observer, Capt. Smyth.

Emersion at $4^h\ 59^m\ 49^s,63$, sidereal time. Instrument, 5-feet achromatic. Dark limb of the moon invisible.

BIGGLESWADE—MR. MACLEAR'S OBSERVATORY.

Observer, Mr. Maclear.

Emersion at $5^h\ 0^m\ 54^s,0$ sidereal time. Instrument, the Society's Wollaston achromatic. Dark limb invisible.

GENEVA—THE OBSERVATORY.

Observers, Messrs. Gautier, Bouvard, and Gambart.

M. Gautier saw no projection of the star on the disc: M. Bouvard saw it projected on the disc one or two seconds: M. Gambart perceived the projection about three seconds.

GREENWICH—ROYAL OBSERVATORY.

Observers, The Astronomer Royal, Messrs. Taylor, Henry, Richardson, Taylor, jun., and Rogerson.

Emersion, the mean of the six observations, $23^h\ 25^m\ 57^s,36$. Dark limb invisible.

LIVERPOOL.

Observer, Mr. W. Lassett, jun.

Star, previous to the immersion, seen projected upon the disc, a quantity equal to its own diameter. Instrument, 9-feet Newtonian reflector, of 9 inches aperture, of which 6 inches only were employed.

PARIS—THE ROYAL OBSERVATORY.

Observers, Messrs. Arago, Mathieu, and Savary.

Previous to the emersion, M. Arago saw the star distinctly on the bright disc about two seconds. M. Mathieu accords with M. Arago. M. Savary states, that the star left, to his eye, a shadow in the place it occupied on the moon's face.

Unfavourable weather prevented this occultation from being observed at Kensington, London, in Scotland, or Ireland.

II. OCCULTATION ON THE 15TH OF OCTOBER, 1829.

BEDFORD—CAPT. SMYTH'S OBSERVATORY.

Observers, Capt. Smyth and John Lee, LL.D.

Immersion at $22^h\ 48^m\ 18^s,96$ sidereal time — Emersion at $23^h\ 24^m\ 7^s,89$. Prior to immersion the star was seen within the lunar disc two seconds and a quarter of time. Both observers agree. Instruments, 5 and $3\frac{1}{2}$ feet achromatics.

BIGGLESWADE—MR. MACLEAR'S OBSERVATORY.

Observers, Mr. Maclear and the Rev. Mr. Bromhead.

Three seconds intervened between the star's first moving forward on the moon's face, and its disappearance. Both observers agree. Instruments used, the Society's Wollaston achromatic, and a 46-inch achromatic.

BLACKHEATH—MONTPELLIER TERRACE.

Observer, Mr. Wrottesley.

The star seen projected on the disc of the moon two seconds. Instrument, 5-inch Gregorian reflector.

CHISELHURST—PARSONAGE.

Observer, Rev. Mr. Hussey.

The star appeared to indent the moon during one second and a half. Instrument, 49-inch achromatic.

ST. GEORGE'S IN THE EAST—PRINCE'S SQUARE.

Observer, Mr. Epps.

Star seen projected on the disc; interval between its first contact and its disappearance, six seconds. Instrument, 30-inch achromatic.

GREENWICH—THE HOSPITAL.

Observer, Mr. Riddle.

Star observed on the lunar disc about one second and seven-tenths. Instrument, 30-inch achromatic.

GREENWICH—The Royal Observatory.

Observers, The Astronomer Royal, Messrs. Taylor, Henry, Richardson, Taylor, jun., and Rogerson.

The Astronomer Royal observed the immersion at $22^h\ 48^m\ 27^s,54$, the emersion at $23^h\ 25^m\ 57^s,04$, sidereal time. The star seemed to hang on the limb, or rather within it, about three seconds of time, and then suddenly disappeared. Instrument, 5-feet equatorial.

Mr. Taylor dates the immersion at $22^h\ 48^m\ 28^s,24$; the emersion at $23^h\ 25^m\ 57,^s24$: to him the star appeared on the disc three seconds, and disappeared, leaving an indentation in the moon's border. Instrument, the 46-inch achromatic.

Mr. Henry observed the immersion at $22^h\ 48^m\ 27^s,69$; the emersion at $23^h\ 25^m\ 57^s,04$. The star seemed to hang on the edge of the moon 5 or 6 seconds. Instrument, 7-feet reflector.

Mr. Richardson gives for the immersion $22^h\ 48^m\ 27^s,89$; for the emersion $23^h\ 25^m\ 57^s,54$. The star seen projected on the moon's disc a quantity equal to two of its own diameters. Previous to its disappearance, the quantity of projection decreased, making an indentation in the moon's border. Instrument, 30-inch achromatic.

Mr. Taylor, jun. observed the immersion at $22^h\ 48^m\ 27^s,89$; the emersion at $23^h\ 25^m\ 57^s,14$. The star was totally included within the moon's limb three seconds before its disappearance. Instrument, 10-feet reflector.

Mr. Rogerson saw the star projected on the disc two or three seconds prior to the immersion, which took place at $22^h\ 48^m\ 27^s,34$; the emersion at $23^h\ 25^m\ 58^s,14$. Instrument, 5-feet achromatic.

ISLINGTON—The Terrace.

Observer, Mr. Simms.

The star seen projected on the disc, previous to occultation, three seconds and a half. Instrument, 45-inch achromatic.

SOUTH KILWORTH—Parsonage.

Observer, The Rev. Dr. Pearson.

Observed the star lying on the moon's limb from $3\frac{1}{2}$ seconds to 4 seconds. Instrument, achromatic of $3\frac{3}{4}$ inches aperture.

KENSINGTON—The President's Observatory.

Observers, Captain Beaufort, Captain Wilson, and Mr. Stratford.

Captain Beaufort observed the immersion at $22^h\ 47^m\ 47^s,68$; the emersion at $23^h\ 25^m\ 4^s,0$. The star was seen to advance upon the moon's limb till its whole diameter was inside the disc. Interval between the star's bisection by the limb and its disappearance was five seconds. Observed with $8\frac{1}{2}$ feet achromatic of $5\frac{8}{10}$ inches aperture.

Captain Wilson determined the immersion at $22^h\ 47^m\ 48^s,18$, and the emersion at $23^h\ 25^m\ 2^s,30$. For three seconds previous to the star's disappearance it was embedded in the moon's limb, with a dark line between the moon and the star. During its advance upon the limb, the star seemed to have its path deranged about 15° towards the moon's centre. Instrument, 5-feet achromatic, of 4 inches aperture.

Mr. Stratford saw the star completely embedded on the body of the moon about three seconds. Immersion at $22^h\ 47^m\ 49^s,18$, (probable error of 1^s in excess); emersion at $23^h\ 25^m\ 3^s,80$. Instrument, 5-feet equatorial.

LAVENDER HILL—Mr. A. Baily's Observatory.

Observer, Mr. A. Baily.

Previous to its disappearance, the star was seen projected on the moon's disc three seconds and two-tenths. Instrument, 5-feet achromatic.

MARSEILLES—Royal Observatory.

Observer, M. Gambart.

Star seen entirely projected on the disc, prior to its occultation, during two seconds. Instrument, 5-feet achromatic.

PARIS—Aux Bains de Tivoli, Rue St. Lazare.

Observer, M. le Baron de Zach.

The Baron saw nothing anomalous; the moment the star came in contact with the moon's limb it disappeared. Instrument, 30-inch achromatic and 40 lines aperture; its object-glass vitro-crystalline, by Cauchoix.

PARIS—À l'Observatoire de l'École Militaire.

Observer, M. Damoiseau.

Star seen adhering to the moon's limb, or as if entangled with it, about one second, but not projected on the disc.

PARIS—À l'Observatoire Royal.

Observers, Messrs. Bouvard, Arago, Mathieu, Nicollet, Savary, and the President.

M. Bouvard saw no projection of the star on the moon's disc. Instrument, 5-feet achromatic, of 4 inches aperture; power about 60.

M. Arago saw the star bisected by the moon's limb, at which time it instantaneously disappeared; the star's semi-diameter was seen on the disc. Instrument, 11-feet achromatic, by Lerebours, of $8\frac{1}{4}$ English inches clear aperture; power about 80 or 90.

M. Mathieu saw the star advance upon the moon's limb about the half of its own diameter; it rested there one second and a half, and then instantly disappeared. The phenomenon of projection, *M. M. states*, was not so strongly marked as on the last

occultation, of the 21st of August. Instrument, the telescope of Reichenbach's repeating circle.

M. Nicollet observed the star projected on the moon's disc, previous to the immersion, about one second and a half. Instrument, achromatic, by Lerebours, of 6 inches aperture.

M. Savary saw the star only partially projected on the moon's disc. Instrument, 5-feet equatorial.

The President, disregarding the clock, fixed his entire attention upon the star; he saw it gradually advance towards the moon's limb; as soon as the contact occurred, the star's apparent eastern rays became gradually invisible, and the instant the star was dichotomised it disappeared. He could detect none of the star's rays projected on the disc. Instrument, 19-feet achromatic of 11 inches and 7-tenths clear aperture, with a power of 360. Both the star and limb, although tremulous, were at moments exquisitely defined. The telescope was adjusted to focus upon the moon's limb.

PARIS—Quai Voltaire.

Observer, M. Pouillet.

If the star did not disappear the moment it came in contact with the limb, it remained there no appreciable time. The moon's limb did not certainly appear behind the star. Instrument achromatic.

Lat. 48° 40′ 50″ N. Long. 11″,5 East of Paris.

Observer, M. Francœur.

The star was seen projected on the disc about four seconds. As the star approached the moon its red tint became diminished, till it resembled the colour of the planet Venus. Instrument achromatic.

PASSY—Terrace in M. B. Delessert's Garden.

Observers, Messrs. Benjamin, François, and Gabriel Delessert.

The instant the star came into contact with the moon's disc it disappeared. All the observers agree.

EAST TYTHERLEY—Tytherley House.

Observer, Mr. F. Baily.

No projection of the star on the disc—nor any thing anomalous detected. Instrument, 42-inch achromatic.

WOOLWICH—Mr. Barlow's Observatory.

Observers, Professor Barlow and Mr. Barlow, jun.

Star seen completely on the moon's disc. Instruments, achromatics of 8 inches and 3 inches aperture; the object-glasses formed with carburet of sulphur. Both observers agree.

Mr. Barlow, in his communication relative to this occultation,

gives the following, as proofs of the capability of his fluid object-glass in exhibiting minute stars:—Following α Serpentis about 30″, he sees a fine, brilliant, but small star; preceding β Serpentis, and at nearly the same distance, a similar star is perceived; south, preceding α Andromedæ, and at a distance of about 40″, is also a small star; forming with the double star α Herculis a very acute-angled triangle, he perceives a small star, not so faint as any of the preceding test stars, but which he thinks would have been registered with α Herculis had it been seen. Again, near Capella, there is a small star at one-third of the distance of the star mentioned by Sir W. Herschel, which, as it is by no means difficult to detect, he is surprised has not been noticed. And lastly, the annular nebula of Lyra has a fine star following it at about 10″; another at a little greater distance; and a third, preceding about 20″, only visible at intervals.

Mr. Barlow concludes his paper by wishing to know how these several objects are seen in the President's large achromatic.*

It is right to remark, that in all the observations here recorded, the moon's dark limb was not visible.

Unfavourable weather prevented the occultation from being observed either in Scotland or in Ireland.

3rd. A letter from Professor Barlow to the President, suggesting an explanation of the cause of the projection of a star upon the moon's disc. This communication having, however, been subsequently withdrawn by the author for reconsideration, the abstract thereof is deferred.

4th. On a method of determining the mass of the moon, from transit observations of Venus, near her inferior conjunction. By Professor Airy.

In consequence of the action of the moon upon the earth, the earth's place is affected with an inequality depending on the moon's position, and proportional to the fraction

$$\frac{\text{Moon's mass}}{\text{Earth's mass + moon's mass}}$$

The observed magnitude of the corresponding inequality in the sun's $\mathcal{R}$ has often been used to determine the value of this fraction. Observations of any other body might, however, be used for the same purpose: and if a body could be found whose distance from the earth was less than the sun's distance, the inequality in its $\mathcal{R}$ would be greater than that in the sun. It is now proposed by

* Since the instrument here alluded to has been in England, it has not been directed to any celestial object. When in Paris, however, it was placed on the annular nebula in Lyra. The small star seen by Mr. Barlow, and estimated by him at 10″ distance, was exhibited almost in contact with the exterior border of the nebula, and capable of bearing considerable illumination of the field. Unless, also, my memory deceives me, there was in the field, with α Herculis, a very minute double star, which I never remember to have previously seen.—J. S.

Professor Airy to observe the $\mathcal{R}$ of the bright limb of Venus, when near her inferior conjunction (at which time her distance is less than $\frac{1}{3}$ of the sun's distance), and, by comparison of the observed $\mathcal{R}$ with that given by the Berlin Ephemeris, to find the error in the moon's mass adopted in that work. The author states, that a similar suggestion has been made by Professor Bianchi with regard to observations of Mars, near opposition in September 1830; and concludes his paper with an ephemeris of Venus for every day of the months of January, February, March, April, and part of May, computed for Berlin; wherein is given, 1st, the approximate N.P.D. of the centre of Venus; 2d, the *apparent* $\mathcal{R}$ of the *bright* limb of Venus on the meridian of Berlin; 3d, logarithms of certain quantities to facilitate the reduction of the tabulated right ascensions for Berlin, to the $\mathcal{R}$ for any other meridian; 4th, the increase of the $\mathcal{R}$ of Venus, in seconds of time, depending on the mass of the moon.

5th. A paper by Mr. Lubbock, being an addition to that read in January last, on the determination of the orbit of a comet.

The author gives the equations relating to this problem, retaining the 3rd and 4th powers of the time, which must be neglected in a first approximation; and he shews how, by a very simple method, the distance of a comet from the earth, obtained approximately, may be afterwards corrected.

At the conclusion of the business of the evening, the President informed the Society, that he had had the good fortune, during the recess, to procure an achromatic object-glass of eleven inches and seven-tenths clear aperture, and of nineteen feet focal length, the work of M. Cauchoix, of Paris; that he observed with it, at the Royal Observatory of Paris, the occultation of Aldebaran by the moon in October last; and that Mr. Troughton had undertaken the arduous task of forming with it an equatorial instrument. The flint glass employed in its construction was the manufacture of the late Guinand le Père, seems to be absolutely perfect, and is a remarkable instance of what persevering industry can achieve, under circumstances the most discouraging.

The President expressed himself under the deepest obligations to his Grace the Duke of Wellington, for the protection and encouragement which, at the instance of Lord Ashley, he had extended to the importation of the object-glass in question, and which, said the President, " will conduce to the placing in the hands of a private individual an instrument which, for delicate astronomical observations, will be superior to any which human ingenuity has hitherto contrived."

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

December 11, 1829. No. 23.

THERE was first read an extract from a letter of Professor Harding to Dr. J. L. Tiarks, dated Göttingen, Oct. 26, 1829.

"In the year 1799 I observed the sun very diligently at Lilienthal, with a 10-feet Dollond, and found that I was obliged to shorten, very considerably, the distance between the eye-glass and the object-glass of the telescope, in order to see the spots near the sun's *limb* as distinctly as those near the *centre* of the disc. Not being able to account for this circumstance, I consulted Dr. Olbers, who considered it to be a mere deception, as, if true, it could not arise from any thing but an increase of distance of the object. The sun's diameter, however, being very small in comparison with his distance from the earth, this cause could not exist in the present case. Six years after, (1805), M. Fritsch noticed the same circumstance, without saying whether he had to shorten or to lengthen the telescope for the objects near the sun's limb. Dr. Gruithuisen has lately again brought forward the same subject, in his *Analecta*, No. 4, § 70; but, quite contrary to my experience, he finds that, for objects near the sun's *limb*, he has to *lengthen*, and for objects near the *centre* of the sun, to *shorten* the distance of the eye-piece and object-glass; and assigns as the cause, the heated atmosphere of the sun, which, he contends, produces a negative refraction; and he then further endeavours to prove, that we necessarily always see the sun's diameter too small, contrary to the usually received opinion, that, on account of the irradiation, it will be always observed too great. Having been requested by him to investigate this subject, I have plainly told him, that my experience of many years had led me to results quite contrary to those obtained by him, and that I had accounted for what I had found, by the fact that the sun's limb appeared less bright than his centre, and that it was well known that less bright objects must be more nearly approached to the eye than brighter ones, in order to have the most distinct vision; — that, agreeably to this fact, I had my telescope shorter for observations of Mars and Saturn, than for those of Venus and Jupiter, which latter are more bright. I am very desirous of knowing what Messrs. Baily and South, and other observers in England, have found in this respect, and how they explain the phenomenon."

The next communication was a letter from Dr. Gregory, pointing out some errors in the places of the planet Ceres, at p. 36 of *White's Ephemeris* for the year 1830.

Dr. Gregory states, that the elements of *Ceres* having received farther correction from recent observations, the right ascensions and declinations of that planet, at and near the opposition in 1830, will be nearly as follow: —

	Æ.				Dec.		
	h	m	s		°	′	″
April 28, noon,	14	46	17	.....	−4	12	54
29, —	14	45	23	.....	4	11	31
30, 8.	14	44	28	.....	4	10	13
May 1, noon,	14	43	34	.....	4	9	1
2, —	14	42	39	.....	−4	7	55

"The geocentric places of Ceres, *for every day at midnight*, (Berlin time), from April 14th to May 16th, are given at p. 248 of *Encke's Jahrbuch* for 1831.

"I may also add, for the advantage of those who may be speedily leaving this country for a year or two, and who prefer the use of the *Connaissance des Tems*, that, in that work for 1831, *the declinations of Jupiter are throughout erroneous, by nearly 2°, for the last six months of the year.* The mistakes may be easily corrected, nearly enough for most purposes, by means of the *Nautical Almanac*, or *Encke's Jahrbuch*. The *Connaissance* for 1832, in which these errors will probably be corrected, is not yet, I believe, arrived in England."

There was next read a paper containing "Remarks on Capt. Thomson's method and tables for working lunar observations at sea, by Baron Zach." The author states, that he was so struck with the remarkable simplicity and conciseness of this method, that he was induced to enter into an examination of the principles on which the tables were constructed, for the purpose of ascertaining whether they were also correct. With this view he computed a great variety of cases, many of which are of a difficult kind, and such as seldom occur in practice, for the purpose of putting those tables to a more severe test. The results he has compared with the solutions obtained by means of the rigorous trigonometrical formulæ used in such cases, and found them, in every instance, almost precisely the same, the difference being seldom more than 1″ or 2″, and in one case only amounting to so much as 6″. He then endeavours to ascertain the mode in which Capt. Thomson has deduced his corrections; and, after much examination, is led to believe that the method is obtained in an indirect manner, and not by means of any analytical expression; and, if so, that Capt. Thomson must have computed upwards of 30,000 cases, in order to complete his tables. This fact has since been confirmed by Capt. Thomson himself, who states, that he computed upwards of 80,000 cases for that purpose. Baron Zach observes, that the principal merit of Capt. Thomson's method is in the application of the *third* correction, since the *first* and *second* corrections are founded on the principles already laid down by Mr. Lyons. He is of opinion that the tables for these first and second corrections may be got rid of, by deducing them from the rigorous formulæ by means of a common table of logarithms; and that, in such case, the only *special* table required will be Capt. Thomson's table for the *third* correction. But, which-

ever mode be adopted for obtaining the first two corrections, he is persuaded that there is no table so concise and accurate, for finding the *third* correction, as that given by Capt. Thomson, who has rendered an important service to the practical navigator, by thus furnishing a method which "deserves to be introduced into, and patronised by, every maritime nation on the face of the globe."

Lastly, a paper was read on algebraical "Notation," by J. W. Lubbock, Esq., wherein the author laments the practice adopted by some writers, of using symbols to denote quantities, without due regard and attention to those made use of by their predecessors to denote similar quantities, whereby much confusion often arises. He therefore suggests a few general rules on this subject, for the consideration of mathematicians. 1. That the notation should never be changed without an adequate motive. 2. That the letters Σ, $\int$, d, &c., which are commonly used as symbols of operation, should never be used as symbols of quantity. 3. That indices of situation should always be placed at the foot of the letter to which they refer. 4. That initial letters should generally be used as symbols of a word written at full length, such as t for time, r for radius vector, &c. 5. That the letters of the Greek alphabet should be used to denote angles. 6. That the same letter should never be used with different meanings. 7. That the letters x, y, z, should be used only for rectangular co-ordinates; with other rules of a similar import. To which was subjoined a Table, shewing the notation adopted by some of the most distinguished writers in astronomy, including also a separate column containing the corresponding letter which the author thinks preferable.

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

January 8, 1830. No. 24.

THE following communications were read:—

1. Extract of a letter from Professor Schumacher to Francis Baily, Esq.

Occultation of Aldebaran, Altona, Dec. 9, 1829:

	h	m	s	
Im.	23	41	12,27	Sidereal time, very exactly observed.
Em.	0	40	51,40	

"There were five observers, so placed that no one could be disturbed by the others. Each had his chronometer, compared before and after with the transit clock. *We saw nothing uncommon at this observation.* The immersion and emersion appeared instantaneous to all, except to Mr. Peterson, who fancied that the star adhered to the bright limb of the moon for a second, at the emersion. But the telescope used by this gentleman was the least perfect of the whole, and shews the stars not as small round discs, but with emerging rays."

2. Extract of a letter from George Dollond, Esq. to W. S. Stratford, Esq.

"The immersion of Aldebaran was observed (Dec. 9, 1829) at Ormskirk, near Liverpool, by the Rev. W. R. Dawes, at $5^h\ 36^m\ 20^s,25$ mean solar time (N. latitude 53° 34′ 15″)

	m	s	
Resulting longitude	11	36,5	West.
Longitude previously determined .	11	36,0	

"I have just received the monthly notice for November, containing a summary of the observations of Aldebaran. The appearances are so variable and uncertain, that I am convinced there is an optical deception depending upon the eye; and I believe the phenomena will vary as the observer directs his particular attention to the moon or to the star.

"On the 21st of August, I observed the occultation, and directed my attention particularly to the limb of the moon, allowing the star to approach, when it gradually disappeared behind the moon, until one-half of its apparent disc was hidden, the last half disappearing instantaneously. I also had an observation of the emersion on the 9th of December, when I allowed the star to pass from the moon for about two seconds, and then directed my attention particularly to the star. *It appeared to stop, and then return towards the moon's limb.*"

3. Observations made with a sextant of Dollond and a reflecting circle of Troughton, for ascertaining within what degree of

accuracy these instruments would give the latitude of a *known* station, by Capt. Basil Hall, R.N.

At the request of Mr. Henderson, who was desirous of ascertaining the degree of accuracy to be expected from nautical instruments, Captain Hall undertook a series of observations to determine the latitude of the Calton Hill Observatory. The instruments used were, a sextant by Dollond, of 11 inches radius divided to 10″, the telescope magnifying eighteen times; a reflecting circle by Troughton, 10 inches diameter, divided to 20″, with three verniers; and an artificial horizon by Dollond. The time was taken from a half seconds' chronometer by Molyneux, compared before and after the observations with the transit clock.

The latitude of the Calton Hill Observatory, as determined by Mr. Henderson from the data of the Trigonometrical Survey, is 55° 57′ 19″,5.

The computations were made by Mr. Henderson from Schumacher's Hülfstafeln, and *no observation rejected.*

DOLLOND'S SEXTANT.

The index always moved the same way in making the observation and determining the index error.

1829,	Latitude.
Sept. 9, by a mean of 24 circum-meridional observations of the sun	55° 57′ 20″,0
16, by a mean of 16 (roof of horizon reversed)	55 57 18,1
by a mean of 40	55 57 19,0

TROUGHTON'S REFLECTING CIRCLE.

Captain Hall conceives there is a slight degree of flexure in the index bar; and that, if the index be pushed from the zero, face left, and also from the zero, face right, the angles given by the vernier will in both cases be too great, and *versâ vice.** To obviate this error, care was taken to move the index *in the same direction*, face right and face left.

	Latitude.
Sept. 12, 13, 14, 15, 16, by a mean of 58 circum-meridional observations of the sun, face east, face west, the roof reversed, &c.	55° 57′ 16″,9

CAPTAIN KATER'S LITTLE CIRCLE (THREE INCHES DIAMETER).

Sept. 11, by a mean of 10 observations of Polaris ..... 55° 57′ 15″,0

The observations were made in the passage of the Observatory, leading to the centre of the building; and Capt. Hall is enabled to contradict most satisfactorily an opinion that the Edinburgh Observatory is unstable or liable to tremors. Though the hill was covered with people, the streets below traversed by carriages and waggons, and workmen were carrying on their operations within the enclosure

* [If these precautions be neglected, it would seem, from Capt. Hall's observations, that an extreme difference of 13″ might arise in his circle from this *cause alone.* Query. Does not this difference arise from a twist in the centre *work ?—Sec.*]

of the Observatory, Capt. H. declares that he never placed an artificial horizon on ground where there were so few tremors.

4. On the longitude of the Armagh Observatory, as determined by transits of the moon and moon-culminating stars, by Dr. Robinson.

This method of determining the differences of longitude between two distant places is superior to all other methods in ease and simplicity, and would seem to be scarcely inferior in accuracy when a considerable number of observations is employed. Ever since the annual lists of moon-culminating stars have been published, Dr. Robinson has regularly observed them, partly to furnish corresponding observations for other astronomers, and partly to confirm and improve the longitude of Armagh, determined by his predecessors. He was thus led to notice a source of error perhaps not sufficiently attended to, and to adopt a correction which he conceives will add to the accuracy of the results to be obtained.

It is well known that telescopes give different diameters of the heavenly bodies, which appear too large in small and inferior instruments. When such are used, the transit of the moon's first limb will appear too early, and that of the second too late; whence, as the stars are wholly unaffected, the longitudes deduced from observations of a single limb will be erroneous to between twenty and thirty times this spurious increase of disc, compared to the disc shewn by the standard telescope of comparison. This error may be easily eliminated when an equal number of transits of each limb can be obtained, but this is obviously impossible in most cases, and inconvenient in all.

The quantity of this optical defect, as it respects the sun, is easily ascertained for any telescope, by comparing the diameter as given by his transit with that given in the Ephemeris, or by the standard transit telescope. Sixty observations of both limbs gave the solar irradiation of the old Armagh transit compared directly with the Greenwich transit + 0ˢ,14, and compared with that of Dublin + 0ˢ,32.

Using these comparative solar irradiations respectively as an approximate correction for the lunar irradiation, Armagh was found to be west of Greenwich,—

	m	s
by 16 corresponding observations ☽ 1 *L* at Armagh and Dublin *	26	23,52
by 10 ——————————— at Armagh and Greenwich	26	26,71

The differences of these from the true longitude (26ᵐ 30ˢ W. nearly) previously determined, being so nearly proportional to the assumed or solar irradiation, Dr. R. was led to conjecture that the lunar irradiation may be obtained, generally, by multiplying the solar irradiation by 1·7.†

* Longitude of Dublin, determined by the Bishop of Cloyne, 25ᵐ 22ˢ W.

† This greater irradiation of the moon may be owing to her greater brilliance, and to the sympathy excited in the adjacent portions of the retina. Dr. R. finds that the lunar irradiation is much less in the day-time. During the winter months, the dark limb of the moon might probably be observed with powerful *telescopes, and the irradiation* determined.

In 1827 the new transit was put up at Armagh, and the solar irradiation was found, by seventy-four observations, to be $+0^s,01$ compared with Greenwich, and $+0^s,19$ with Dublin, through the data of the *Nautical Almanac*; whence the comparative lunar irradiations would be respectively $+0^s,02$ and $+0^s,32$, on the preceding hypothesis. With this correction, the longitude of Armagh was found to be

		m	s	
by 10 corresponding observations	☽ 1 *L* Armagh and Dublin	26	30,49	W.
5 ———	☽ 2 *L* ———	26	30,34	W.
	Mean . .	26	30,40	

which must be very near the truth.

by 6 corresponding observations at Armagh and Greenwich 26 29,89

but with a much greater probable error.

It would appear, therefore, that this mode of obtaining the comparative lunar irradiation applies to the new transit as well as to the old.*

All the results have been obtained by the method of minimum squares, and the probable errors are also given.

The formula is stated, by which the longitude is deduced from the observations, with a type of the calculation.

* Old transit of Armagh 3 ft. focal length, 2 in. aperture, partly covered by an illuminator.

New ———	5 ———	$3\frac{3}{4}$ ———	limited for sun and moon to $2\frac{3}{4}$.
Greenwich transit .	10 ———	5 ———	
Dublin transit . . .	6 ———	4 ———	of which $2\frac{3}{4}$ only are used.

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

February 12, 1830. No. 25.

Report of the Council of the Society to the Tenth Annual General Meeting, held this day.

YOUR Council have the pleasure to announce in this, the Tenth Annual, Report, the increasing prosperity, efficiency, and consideration of the Astronomical Society.

The following abstract of the receipts and expenditure during the preceding year, will shew the present state of the funds of the Society; viz.:—

Receipts.	£.	s.	d.
Balance of last year.....	335	3	3
Arrears, Feb. 1829:—			
Resident members	62	15	0
Non-resident ditto	33	12	0
Contributions for 1829-30;—			
8 admission fees	11	11	0
Resident members	161	14	0
3 non-resident ditto.....	25	4	0
1 non-resident fee	4	4	0
1 composition	21	0	0
1 year's dividend on 800*l.* consols	24	0	0
1 yr.'s do. on 857*l.* 13*s.* 8*d.* new 4 per cents	34	6	0
By sale of the memoirs.....	45	2	0
	£758	11	3

Expenditure.	£.	s.	d.
Printer's bill for Vol. III. Part II.	270	14	7
Robinson's bill, last year...	22	5	0
Repairs of instruments.....	15	12	0
Lithographer's bills	8	0	0
Engraver's bills	2	13	6
1 year's rent to Michaelmas	52	10	0
Commission to collector ...	17	10	0
Sundry disbursements for porterage, postage, &c, including an arrear due to former Secretary.....	38	3	9
Balance	331	2	5
	£758	11	3

And the assets and present property of the Society are as follow; viz.:—

Assets of the Society.

	£.	s.	d.
Balance in the hands of the Treasurer	286	2	5
Due from Messrs. Baldwin and Co. booksellers, about.....	50	0	0
Due from Messrs. Priestley and Weale, booksellers, about	70	0	0
Arrears, Feb. 1830:—			
2 contributions of four years' standing	16	16	0
3 ——— of three ditto	18	18	0
10 ——— of two ditto.....	42	0	0
8 ——— of the past year	16	16	0
1 change of residence.....	4	4	0
5 non-resident members.....	42	0	0
	£546	16	5

800*l.* stock in the 3 per cent. Consols.... } 857*l.* 13*s.* 8*d.* ditto in new 4 per cents... }	valued at about	1600	0 0
Books unsold, now in hand.....			
Various astronomical instruments			
Eleven silver medals unappropriated.....			
From the above, however, are to be deducted—			
The printer's bill for Vol. IV. Part I. now in progress			
——————— sundries.....		24	5 8
Cost of three gold medals omitted to be carried to account		30	7 6
A few sundries, estimated at about.....		20	0 0

Agreeably to the fundamental Rules of the Society, no bills above the amount of five pounds can be paid by the Treasurer, without having been previously examined and approved of by the Council; and the annual accounts are afterwards again examined, prior to the General Meeting, by a Committee appointed for that purpose. All the documents are deposited with the Secretary, and may be inspected by any member of the Society.

The progress and present state of the Society with regard to the number of its members and associates, may be seen from the following abstract, continued from the Report of last year; viz.:—

	Compounded.	Resident.	Non-resident.	Honorary.	Total Members.	Associates.	Grand Total.
Feb. 1829 . .	40	92	99	1	232	32	264
Since elected	1	9	9	—	19	2	21
Since lost . .	—	6	2	—	8	—	8
Feb. 1830. .	41	95	106	1	243	34	277

Amongst the deaths, the Society have to regret the loss of Mr. Edgeworth, a gentleman of the highest promise and attainment, and worthy of a name dear to science and to literature.

The exquisite transit circle by Troughton, of two feet diameter, presented by Dr. Lee, is now in the possession of Captain Smyth, after receiving from the hands of its maker some important additions and improvements. Upon these much time was necessarily expended, and since the instrument was placed in the Bedford Observatory, the weather has not allowed Captain Smyth to prosecute the delicate researches in which he is engaged. The Society will have remarked with satisfaction the excellent observations of occulted stars by this active astronomer, and by Mr. Maclear, to whom Dr. Wollaston's telescope was intrusted. The transit clock presented by Lieutenant Beaufoy, and now in the possession of Mr. Herschel, has been lent to the Rev. Michael Ward, and will be forwarded to him by the first opportunity. The Beaufoy circle has

been safely received, but too recently to have enabled Mr. Ward to furnish the observations which may be expected from his zeal and attainments.

A library has been formed, of considerable extent and value, from the contributions of individuals and scientific bodies. The want of any means of consulting this has long been felt; but the Council have the gratification of stating, that Professor De Morgan has offered his valuable services to arrange and catalogue the books and manuscripts belonging to the Society, a task which is now nearly completed. It is well known that the Council have long been endeavouring to procure more convenient apartments for the use of the Society, such as would be better adapted to their increasing demands, and under a more permanent tenure than those which they now hold. It is to be regretted that so desirable an object has not hitherto been attained.

Upon the increasing attention paid to our noble science, it is scarcely possible to speak in terms too flattering. In addition to the increased activity of public observatories, the exertions of private individuals are by no means slackened in this race of improvement. A magnificent achromatic object-glass, the masterpiece of Cauchoix, and of the largest dimensions, having $11\frac{3}{4}$ inches clear aperture, and 19 feet focal length, has been purchased by our spirited President. The task of mounting this gigantic telescope equatorially, has been undertaken by the most celebrated of our modern artists, and we may hope to see this active astronomer speedily engaged in pursuing, with unequalled means and unabated ardour, the path of discovery in which he is already so advantageously known.*

Your Council trust, that they have not been backward in promoting, to the utmost of their power, every attempt to advance the interests of the science of Astronomy.

Before the departure of Captain Ross on his Arctic expedition, that enterprising officer proposed to make any scientific observations, for which his situation might be considered favourable,

* [Although this telescope was placed on a temporary stand, at the President's Observatory at Kensington, on January 29, the weather did not permit of any trial of its powers *previously* to the anniversary. It may now, therefore, be interesting to state, that the first night on which an opportunity was afforded, viz. the 13th of February, Mr. Herschel discovered a *sixth* star in the trapezium in the nebula of Orion, a few degrees south following of, and about five or six seconds distant from, the star denominated A in that trapezium, in Mr. South's observations of the double stars. Its brightness is about one-third of that of the fifth star, discovered by M. Struve, which is as distinctly seen as the companion to Polaris is in a five-feet achromatic. It was immediately after detected by Mr. South, and has since been seen by Mr. Baily, Mr. Troughton, Mr. Sharpe, and others, and repeatedly by myself. Saturn, with his Belts, Double Ring, and Seven Satellites, is beautifully defined, with powers of 130, 280, and 350. The object-glass is not in very perfect adjustment; it was placed in its cell, as now used, by mere accident, and, in consequence of unfavourable weather, it has not been deemed prudent hitherto to attempt any alteration.—W. S. S. *Sec.*]

should he unfortunately be detained upon his perilous route. An application was made by him to the Lords of the Admiralty, and supported by your Council, for a loan of the requisite instruments, which was received by their Lordships in a most gratifying manner. Captain Ross was amply supplied with the proper instruments; and, at the request of the Council, a list of moon-culminating stars, for the months of January, February, March, and April, 1831, was prepared for him by Mr. Henderson, the Astronomer Royal having undertaken that the corresponding observations should be made at Greenwich.

The numerous and excellent observations of Aldebaran, during the preceding year, which have been already communicated, are a satisfactory proof of the increased interest felt for the science, and of the importance attached to the views and wishes of the Society. In some instances the star disappeared instantaneously after the bisection of its disc by the moon's limb, while in others the projection lasted nearly six seconds. It does not appear that a sensible diminution of brightness was perceived previous to immersion. When a sufficient number of well-attested appearances has been collected, it may be possible to account for the anomalies which have hitherto been so perplexing. The attention of astronomers towards this interesting phenomenon is earnestly requested during the present year. Neither should the predicted occultations of other stars be neglected by observers. It is from them that the most accurate determinations of longitude are, in the generality of cases, to be obtained; and the tedious difficulties with which they were embarrassed, have been in a great measure removed. The Council have distributed from time to time monthly notices of the principal lunar occultations, for the meridian of Greenwich, computed by Mr. Henderson, to whom this branch of astronomy is under peculiar obligations. It is to be regretted that the avocations of this gentleman will not allow him to continue these useful lists much longer. Fortunately, this loss is greatly diminished by a recent memoir due to our excellent associate Professor Bessel, and inserted in *Encke's Ephemeris* for 1831, which gives a short and simple method of transferring to another meridian the time and circumstances of an occultation already computed for Berlin, along with the quantities required for the calculation. These subsidiary quantities have been prepared for the first six months of the present year by Professor Troeger of Dantzic, and inserted in the *Astronomische Nachrichten*, an early copy of which was transmitted to the Society by the accomplished editor. This has been printed for distribution, in the hope that the zeal of Mr. Henderson will find worthy successors. To mark their sense of obligation to this gentleman, and as a small tribute of respect, the Council have unanimously agreed, "That it be recommended to the general meeting to present to Mr. Henderson a copy of the Memoirs, handsomely bound, for the very valuable assistance which he has rendered to the cause of Astronomy

in his various computations presented to the Society."* The numerous communications that have from time to time been received from Germany, and the valuable astronomical works that are constantly issuing from the press of that country, render an acquaintance with the German language almost essential to the prosecution of the science. The difficulty which the Council would otherwise have experienced has been greatly removed by the cordial and very valuable assistance of a gentleman deeply versed in every branch of the science, who has, on all occasions, been ready in favouring the Council with translations of such papers as they have from time to time required. To mark their sense also of this obligation, and as a small tribute of respect, they have agreed, "That it be recommended to the general meeting to present to Dr. Tiarks a copy of the Memoirs, handsomely bound, for his kind and ready assistance at all times in translating various foreign papers for the use of the members, and for other valuable services rendered to the Society."*

A simple and ingenious method of determining the mass of the moon, by observing the R.A. of the bright limb of Venus, has been proposed by Professor Airy, with a request that the Society would use their influence in obtaining for it an extensive circulation. Copies have, accordingly, been forwarded to every public and private observatory in Europe, with a strong recommendation for its adoption.

The fluctuating use of symbols in mathematical investigations more frequently occasions mistake and misapprehension than the inherent difficulty of the subject matter; and it is to be lamented that so little care is taken by the generality of authors to be consistent with each other, or even with themselves. An attempt has been made by Mr. Lubbock, under the auspices of the Society, to introduce a system of notation depending upon fixed rules. This paper is now in the press, and will be submitted before publication to the geometers of this and other countries. In this way, it seems probable that a considerable degree of accordance may be obtained, which it is hoped may be strengthened and confirmed by the sanction and practice of the Society.

The paper upon the Constant of Aberration, by Mr. William Richardson, to which such marked attention was drawn in the Report of last year, has subsequently been published in the Memoirs of the Society, and fully justified the high expectations excited. The immense labour bestowed upon this important investigation, the clearness with which it is developed, and the number of observations on which it is founded, must command the admiration of all astronomers. Your Council have unanimously awarded to Mr. Richardson the gold medal for the determination of this fundamental constant.

* [The recommendation of the Council in each of these instances was unanimously approved of, and adopted by, the Members at the General Meeting.—*Sec.*]

A gold medal has also been voted to Professor Encke for the superb Ephemeris of Berlin. It would be superfluous to dwell here upon the merits of this well-known work, which, far outstripping all rivalry, must be considered as the only ephemeris on a level with the present wants of the science,—the manual and standard of practical astronomy wherever it may be cultivated.

The President will deliver the medals at the close of this meeting in the accustomed form.

Your Council trust that this exposition of the resources and progress of the Society will be satisfactory to the members at large; but it is not to be forgotten, that much remains to be done, and that more labourers are demanded. It is not sufficient to thank or to admire those who have toiled in the good cause,—the necessity of imitation must be strongly felt and inculcated. There is scarcely any instrument which may not be usefully employed, or any acquirements which may not perform good service. Phenomena may be predicted, preliminary computations furnished, reductions prepared, with little more knowledge than that of common arithmetic; occultations, eclipses, moon-culminating stars, planets, may be observed, and portions of the heavens examined and surveyed, with instruments of moderate price and of inferior dimensions. Indeed, in the present state of astronomy, the class of *differential observations* embraces far the greater portion of celestial phenomena even for the best instruments; and by the publication of the Berlin Ephemeris, computation is almost wholly reduced to simple interpolation. At no distant period it may be possible for the Council to provide skeleton forms, not merely for registering observations, but for their reduction and for all ordinary calculations.

It would also be highly desirable to collect and publish annually, in a condensed form, observations presented to them by British and foreign astronomers, and not printed elsewhere,—a repository and digest of the services of amateur observers. The Council confidently rely upon the energy and activity of the members, and of all friends to astronomical science, for the accomplishment of this important object. Thus, not only will a large mass of valuable information be rescued from oblivion, and preserved in a shape the best adapted to comparison and use, but a deeper interest will be felt by the contributor, and a stronger motive offered for that care and method, without which computation is rendered useless, and instruments degenerate into toys.

(*The President then addressed the Meeting on the subject of the award of the Medals, as follows:*—)

Gentlemen,—Ere we proceed to the distribution of our honorary rewards, I cannot but congratulate you on the general state of astronomical affairs: whether we turn to the north or to the south, to the east or to the west, the astronomical horizon presents a more promising aspect than it has done for many years; and what is peculiarly gratifying to us is, that amidst the general endeavours to advance

astronomical knowledge, our own country this year stands indeed conspicuous. Since our last anniversary, the observations of Professor Airy have done honour to the University of Cambridge; those of Dr. Robinson have rewarded the munificence of the Primate of Ireland; and others made at Paramatta, in the observatory founded by Sir Thomas Brisbane, and which (thanks principally to the exertions of members of this Society) is now become an observatory in the service of the British government, give us an earnest of the value of those observations of Sir Thomas's, now in the course of reduction by Mr. Richardson, as also of the importance of others, which, on the authority of the government, we are henceforth regularly to receive from Paramatta. Again, within these few days has arrived a first series of standard transit observations, made by Mr. Fallows at the Cape Observatory. They are, as yet, unpublished. Knowing him, however, intimately as I do, and having witnessed his early astronomical career, I may be permitted to felicitate you on their arrival, confident that whatever comes from him will be honourable to his country, for it will be worthy of himself. But that these observatories have rendered to us their first fruits, is not all: others are in a state fast approaching to practical utility; and when another year shall glide away, he who shall have the honour to fill the chair I now so unworthily occupy, will have, I hope, to applaud the activity of the observatories of Brussels and Cadiz, of Cracow and of Edinburgh, of Geneva and Madras.*

While exulting, however, in the accession of these new observatories, let us not forget honourably to notice, that from the Royal Observatory of Greenwich has issued, but a few weeks since, a Catalogue of 720 Stars;—a valuable treasure, and for which the astronomical world is indebted to this Society, as well as to the Astronomer Royal; inasmuch as the stars it embraces have been selected from, and reduced by, the Society's Catalogue. On examining the important facts resulting from this first series, and which the Astronomer Royal has exhibited by actual comparison with our own work, let us hope, now that his fundamental catalogue has reached a degree of accuracy probably unexampled in astronomical history, he will persevere in the task; assured as he may be, that no one thing would tend more to the credit of the Observatory, and to his own glory, than that his name should be attached to a large catalogue of stars, called, as in the good old times of Flamsteed, "*The British Catalogue.*"

The Royal Observatory of Paris is also an object of increasing interest; a splendid equatorial by Gambey has been added to its previous collection; and the transit instrument by the same distinguished artist, so long and so anxiously looked for by our *confrères*

* This is not literally a new observatory; the instruments, however, now about to be sent thither, are so far superior to those already there, that it may almost be regarded as a new establishment. The same applies to the Geneva observatory, but with greater force; for not only are superior instruments ordered for it, but a new building is being prepared for their reception.

of Paris, is at length placed on its piers; whilst the Observatory, *properly* so called, is about to be remodelled and rendered more convenient for astronomical labour. We hail the recommencement of the observations as an era which will be worthy of the country of Cassini,* of La Caille, and of La Lande;—of La Grange, Legendre, and La Place. The sentiments of the late distinguished Secretary of the Institute, that "*Ce n'est pas le tout que de fonder un observatoire et de doter l'astronome, il faudrait faire un fonds annuel pour l'impression, et imposer à l'astronome l'obligation de n'être jamais en retard d'une année,*"† being adopted by the astronomers of Paris, we shall not have to regret that observations, made with such instruments and by such men, shall be available only to those who reside within the walls of the observatory. We have this year set our Parisian friends a splendid example, and doubtless they will follow it.

As to the improvement of the achromatic telescope, since our last anniversary, much cannot be said. The theory of Mr. Rogers has not, as far as I know, been put to the test of practice, in a manner at all commensurate with its merits; whilst Mr. Barlow's achromatic, of eight inches aperture and eleven feet focal length, owing to imperfections in the material of its exterior lens, does not define close sidereal objects so neatly as might be wished, but is, nevertheless, applicable to many useful purposes; and there is a hope that the labours of a sister society, although hitherto unsuccessful in furnishing us with the mode of making good *flint* glass, will shortly put us in possession of at least a succedaneum for it.

Some of the members‡ of the Society, regretting that the late Board of Longitude was not remodelled instead of being dissolved, had, during the last spring, several interviews with His Majesty's ministers on the subject of a new one. A plan for the constitution and regulation of a new Board was shewn to the First Lord of the Admiralty; and was *only* not introduced to the consideration of Parliament at the instance of the projectors of it, in consequence of a wish expressed by Lord Melville, that a bill drawn up in its spirit should be presented to the Legislature by the Admiralty officers. The question which at that time, and during the remainder of the session, so completely engrossed the attention of the government, being now disposed of, let us hope, that the pledge then given will be remembered, and that on our next anniversary we shall have to thank the government for having given us a Board of Longitude, which shall be worthy of the first maritime nation in the world.

* Cassini was an Italian professor; he was, however, called to Paris by Colbert, whose comprehensive mind felt that not only military success, but scientific reputation could confer glory on his country. Not only did he place the observatory of Paris under the care of Cassini, but men of all countries who had distinguished themselves by their scientific acquirements were invited by that illustrious patron of science to reside in Paris. He was also the founder of the Académie des Sciences, and of the Observatory of Paris.

† Hist. de l'Astron. au XVIIIème siècle; par Delambre, p. 115.

‡ Lord Ashley, Mr. Francis Baily, Captain Beaufort, and the President.

As connected in some measure with astronomy, we see the geodetic operations in Ireland carried on with vigour, under the superintendence of Colonel Colby; whilst for triangulating our Indian empire (thanks to the scientific spirit of the Directors of the East India Company), such a battery of field apparatus is nearly prepared by Troughton and Simms, as, in even less able hands than those of Captain Everest, could scarcely fail to immortalise him who should have the happiness of using it.

Again, we have the pendulum investigations of our associate, Professor Bessel, shewing that the corrections employed by British philosophers for the reduction to a vacuum are far from accurate; and, to come nearer home, our ever active member, Mr. Francis Baily, has demonstrated that certain imperfections and discordances exist in the apparatus employed by previous experimenters, which point out the absolute necessity of fresh inquiries being instituted, ere we can pretend to be possessed of accurate estimations either of measure or of weight.*

But our Society was not founded solely for the investigation of astronomical refinements — practical utility was to go hand in hand with it: geography was to be improved; and hydrography, so essential to the well being of our maritime country, was not to be neglected. To advance our knowledge of the former since our last anniversary, British intrepidity, undaunted by previous defeat, has left our shores, and is now struggling in the Victory to achieve that, which the perseverance of a Parry, backed by the exchequer of Great Britain, was forced, after repeated trials, to abandon in despair. And the no less interesting part of the history is, that the expense of the attempt (which God grant may be successful!) has been defrayed by the princely liberality of an English gentleman, whose modesty withholds his name from the public.

Again, as to hydrography: scientific surveys are gradually spreading to every quarter of the globe, under the influence of the noble Lord who has lately enrolled his name in this Society. But little does it matter if coasts are well surveyed, rocks detected, shoals discovered and currents ascertained, if the results are not digested so as to be practically useful to the seaman. It gives me pleasure, therefore, to announce, that since we last met, an appointment has been made by the Admiralty, which has given universal satisfaction; for it assures us, that the day is not far distant, when an Englishman shall visit the hydrographic department of the *Depôt de la Marine* of a neighbouring state, without feelings humiliated by the comparative inferiority of the corresponding establishment of his own country.

Proceed we now to the distribution of our medals. By the minutes read at the table, you have been informed that "one of them

* A standard measure, on a new construction, has been ordered by the Council, since the delivery of this address, and is now in course of completion by Troughton and Simms.

has been decreed to Mr. Richardson for his investigation and determination of the constant of aberration, from observations made at Greenwich with the two mural circles; the other to Professor Encke, for his *Berlin Ephemeris.*"

Three hundred years have now elapsed since Copernicus proposed to the world that system which bears his name; and if we except the labours of Tycho Brahe, who, besides a catalogue of 800 stars, made attempts to determine the altitude of the pole-star at different seasons of the year, little was done by practical observation to support or refute the ideas of Copernicus till the time of Galileo. Observations of the eclipses of Jupiter's satellites induced him to propose them as a means of determining differences of longitude, whilst his discovery of the phases of Venus removed a serious objection to the truth of the Copernican system, and which Copernicus himself predicted would be removed, though he had not the means of doing so himself. About the year 1665, Huygens, by his discovery of the pendulum clock, gave to astronomical observations an accuracy hitherto unknown; and Cassini, by means of the excellent glasses of Campani, accumulated a vast mass of observations of the eclipses of Jupiter's satellites, and deduced from them tables whereby astronomers could predict their occurrence.

Notwithstanding the powerful arguments advanced in its favour, the Copernican hypothesis was not generally embraced; for in the year 1669, nearly a century and a half subsequent to its promulgation by Copernicus, even the celebrated Hook, to use his own words, "would not absolutely declare for it."* To settle the matter, therefore, this extraordinary man, feeling that the instruments of Tycho, although magnificent beyond all others, were, from the nature of their construction, and from their being unprovided with telescopic sights, incompetent to detect minute alterations of sidereal positions, and knowing that the laws which governed refraction were so little understood† as to render all observations in which that element was materially involved, liable to errors greater probably than the quantities he was in search of, invented the zenith sector. It was erected at Gresham College, and consisted of a telescope 36 feet long, a divided arc, and a plumb-line. The star selected for observation, and with reference to which, indeed, his instrument was entirely constructed, was one which passed within two or three minutes of the zenith of Gresham College, was visible in the day-time throughout the year, and was γ *Draconis:* by observing its zenith distance when the earth was in opposite points of her orbit, he found (as he erroneously concluded) a sensible parallax, amounting to about 20 seconds, and, consequently, determined that the Copernican system was the true one.‡

* An Attempt to prove the Motion of the Earth, from Observations made by Robert Hook, F.R.S., pp. 5 and 7.

† Idem, pp. 10 and 11.

‡ An Attempt to prove the Motion of the Earth, from Observations made by Robert Hook, F.R.S., p. 25.

In the mean time, the eclipses of Jupiter's satellites, thanks to the facilities of predicting them afforded by Cassini's tables, had been assiduously observed; and in the year 1675, the discordances found between the predicted aud the observed eclipses enabled the celebrated Roëmer to demonstrate that light was not instantaneously propagated, and that the discordances between the tables and the observations might be considered as the measure of its velocity.

The year of Roëmer's discovery was further marked by another epoch in astronomical history, namely, the foundation of the Royal Observatory. Flamsteed, with his mural quadrant, detected a change of place in the pole-star, amounting to 35, 40, or 45 seconds, attributed it to parallax, and regarded it as confirmatory of Hook's discovery. Indeed, the observations of Hook, as well as of those who preceded him, although nominally in search of parallax, had for their object little else than the confirmation or verification of the Copernican system; and this arrived at, there seems to have been but little disposition to repeat them.

Hence it was that the brilliant discoveries of Newton having placed the accuracy of the Copernican system beyond all possibility of doubt, the investigation of parallax was not resumed till the latter end of November, in the year 1725, at which time Molyneux erected his 24-feet zenith sector, by Graham, in his observatory at Kew.* "On the 3d of December, γ Draconis was, for the first time, observed as it passed near the zenith, and its situation carefully taken with the instrument; and again, on the 5th, 11th, and 12th, when, no material change in the star's place having been detected, further observations seemed needless, since it was a time of the year when no sensible alteration of parallax could soon be expected." Bradley, however, being on a visit to his friend Molyneux, was "tempted by curiosity to repeat the observation on the 17th, and perceived the star pass a little more southerly than when it had been observed before:" suspecting that the apparent change of place might be owing to erroneous observation, it was observed again on the 20th, and he found the star still farther south than in the preceding observations. This sensible alteration surprised himself and Molyneux, inasmuch as it was the contrary way from which it would have been, had it proceeded from an annual parallax of the star; but being incapable of accounting for it by want of exactness in the observations, and having no notion of any other cause from which such apparent motion could proceed, they suspected that some change in the materials of the instrument itself might have occasioned it. Under this apprehension they remained some time, but being at length fully convinced, by repeated trials, of the great exactness of the instrument, and finding, by the gradual increase of the star's distance from the pole, that there mus be some regular cause which produced it, they

*Philosophical Transactions, vol. xxxv. p. 639.

examined nicely at the time of each observation how much it was; and about the beginning of March 1726, the star was found to be 20″ more southerly than at the time of the first observation. It now, indeed, seemed to have arrived at its utmost limit southward; for in several observations made about this time, no sensible difference could be detected in its situation. By the middle of April it appeared to be returning towards the north, and about the beginning of June it passed at the same distance from the zenith as it had done in December, when it was first observed. From the quick change in the star's declination about this time (it increasing a second in three days) they concluded that it would now proceed northward, as it before had gone southward of its present situation; and it happened as was conjectured; for it continued to move northward till September following, when it again became stationary, being then near 20″ more northerly than in June, and no less than 39″ more northerly than it had been in March. From September it returned towards the south, till it arrived, in December, at the very same situation it had been at that time twelve months, allowing for the difference of declination "on account of the precession of the equinox."

Such is a brief history of the Kew observations; commenced, indeed, for the determination of sensible parallax, but which, as subsequently in the hands of Herschel, led to a very different result. In reading it, we are at a loss whether most to admire the mode in which the observations were conducted, or the modest unassuming manner in which they are recorded: no possible source of error is allowed to pass without the most rigid examination—no theory suffered to embarrass the observers in their observations; the slightest anomaly became the subject of suspicion, till in presumed anomaly was found the most perfect regularity.

That observations so conducted, leading to results so unexpected, could be abandoned till the law which governed them should be unfolded, was impossible. But Bradley rejected all inquiries into the cause till the effects were accurately determined; and feeling that the apparent motion was obtained by observations only of one year—by one instrument—and by one star,—he erected at Wanstead, aided by his friend Graham, on the 19th of August 1727, his zenith sector of 12½ feet focus, formed, indeed, upon the same general plan of Molyneux's, but furnished with a divided arc of 6½ degrees on each side of the zenith point, for the purpose of enabling him to ascertain, by direct observation, whether other stars than γ *Draconis*, would be similarly affected. The instrument's situation, when adjusted, "might be securely depended upon to half a second," and its telescope could be directed to "not less than 12 stars, bright enough to be seen in the day-time" throughout the year: the same changes were observed as had been previously detected with Molyneux's instrument. Inflexible, however, in his resolution not to generalise till sufficient means were collected to lead him to a "probably just conclusion," the year of

probation was suffered to be completed before "the observations were examined and compared:" *then* it was that he satisfied himself of the general laws of the phenomena; and *then*, and not *till then*, did he endeavour to find out their cause. Convinced that the apparent motion of the stars which he had observed was not owing to nutation—persuaded that a change in the direction of the plumb-line with which the instrument was rectified, was insufficient to have occasioned it—and having appealed unsuccessfully to refraction,—he perceived "that if light was propagated in time, the apparent place of a fixed object would not be the same when the eye is at rest as when it is moving in any other direction than that of the line passing through the eye and the object; and that when the eye is moving in different directions, the apparent place of the object would be different." He therefore announced his discovery in these words: "That all the phenomena proceeded from the progressive motion of light and the earth's annual motion in its orbit," or, as he afterwards called it, aberration of light.

But he who determined its existence determined also its constant, and fixed it at 20″; giving us, therefore, the interval of time in which light travels from the sun to the earth, as eight minutes and seven seconds, differing from that deduced by Roëmer nearly three minutes of time, a circumstance not at all to the discredit of Roëmer, considering the imperfect knowledge of the theory of Jupiter's satellites at the time he made his important discovery.

The observations, however, which led Bradley to the discovery of aberration, and to the determination of its constant, being as yet unpublished, have given rise to insinuations certainly ungenerous, and probably unjust. Impelled by more honourable feelings, our illustrious associate Bessel, alluding to the observations of *γ Draconis* made by Bradley when the sector was removed to Greenwich, says,* "*Cæterùm Bradleii observationes Wansteadianæ liberari possunt à sectoris mutabilitate, quum sæpiùs, eodem tempore, observatæ sint stellæ, in quibus aberrationi contraria fuerunt signa: quâ de causâ, et propter observationum præstantiam, optabile esset reperire ipsa Bradleii autographa.*" It will, therefore, be highly grateful to him, and to astronomers in general, to be informed from this chair, that the manuscripts of the Wanstead observations are found!—that, to the honour of the University of Oxford, twenty-three sheets of them are already printed; and that the volume will be presented to the public with as little delay as possible, under the superintendence of Professor Rigaud.

Till within these few years, the constant, as determined by Bradley, was universally employed in all our astronomical reductions; recently, however, astronomers have re-investigated it. Delambre, from the eclipses of Jupiter's satellites, regards it as 20″,25. Bessel, from Bradley's observations made at the Royal Observatory,

* Fundamenta Astronomiæ, p. 124.

after he was appointed Astronomer Royal, has deduced for the constant 20″,68. Lindenau, by comparisons of Bradley's, Maskelyne's, Bessel's, and Pond's observations of *Polaris*, has obtained for it 20″,61. Brinkley, from his own observations, considers it as 20″,37. Whilst Struve, by his observations, draws almost the same inference, namely 20″,35.

Such were the results most entitled to our confidence, when Mr. Richardson, in the hours allotted to him for repose or recreation, undertook those labours which form the subject of our present consideration, and of which the following is a brief outline. A second mural circle by Jones, after the model of that of Troughton's, having been erected at the Royal Observatory, in the April of 1825, corresponding observations with the two instruments were carried on simultaneously; they were confined, indeed, to a few stars, but every precaution to render them as accurate as possible was adopted. Thus, the index error of each instrument was ascertained by observing the same star alternately, by direct vision and reflection; each pair, therefore, giving to its respective instrument one horizontal point perfectly independent of astronomical tables, the final accuracy of the determination of the index error being directly as the number of pairs observed. Throughout the observations, the place of each star was arrived at by reference to the six microscopes of each circle; care also being taken to equalise, as nearly as possible, the temperature of the observatory with that of the external air, so that errors to any extent, arising from partial expansions or erroneous divisions of the instrument, were effectually excluded.

From such unexceptionable data, fourteen stars were selected by Mr. Richardson as the fittest for his purpose, being those the least affected by refraction, and the most affected by aberration, so that the errors of observation might have the minimum influence upon the results. Upwards of 4,000 observations he separately discussed, and in no instance was the actual aberration of each observed star less than 14″; and the conclusion to which he has arrived is, from Troughton's circle, that the Constant of Aberration is 20″,505; whilst by Jones's it is 20″,502, the one differing from the other but three-thousandths of a second.

Hook, in searching for parallax, was misled by his instrument. Bradley, in detecting it, was unsuccessful, but discovered aberration. Hook's instrument was the work of his own hands; Bradley's was the work of Graham. Sensible that much of his astronomical glory was referable to the accuracy of his instrument, the amateur astronomer of Wanstead was ever ready to acknowledge it; and when we consider that one hundred years' improvement in astronomical manipulations can alter the constant of aberration as determined by him but one half second,* we are almost led to exclaim "*quando ullum inveniemus parem?*"

* It is not impossible that much of this discordance will disappear when the Wanstead Observations shall be reduced with modern precision.

Our Graham is amongst us; to him we are indebted for the instruments with which results thus important have been obtained, and also for the mode of using them, through which the maximum of accuracy has been acquired. One of them was made with his own hands, the other under his direction; and it is not too much to say, that the disciple has shewn himself worthy of his master. The benefits which Edward Troughton has conferred on science, are too well known to need enumeration. His Majesty the King of Denmark, not insensible to the importance of science, and feeling that for much of the accuracy to which astronomy and navigation have arrived, we are indebted to the genius of our revered member, has recently acknowledged his gratitude to him, by the presentation of his gold medal, inscribed with the word "MERITO." Never was inscription more appropriate. May he live long to enjoy this token of respect! alike honourable to himself and to the princely feelings of its royal donor.

On looking over the constant as determined by each star, nothing definitive, as Mr. Richardson justly observes, can be concluded, as to whether light emitted from different stars is propagated to us with different degrees of velocity: the idea is not irrational, but its validity future astronomers must determine.

(*The President then, addressing Mr. Richardson, continued thus:*—)

Mr. Richardson,—Brought up to an employment little allied to astronomy—residing in a part of the country remote from the metropolis—cut off from the society of scientific men, which operates so powerfully in stimulating to scientific exertions,—we see you quitting the place of your birth,—leaving the roof of your respected parents,—and presenting yourself in this great city, known only to a single individual; abandoning every sordid pursuit to follow that which, however noble, too often leads, in this country, to neglect and poverty—we find you, in August 1822, at the Royal Observatory as an assistant. Here you soon distinguished yourself by your punctuality—your attention—and your zeal; accustomed to the business of an observatory,* you required to be instructed only in the established routine of that to which you were appointed. Soon did you gain the confidence of the Astronomer Royal; and whether he wished to establish the place of a star in the heavens, or of a spot on the earth, to no one could he intrust the one or the other with more confidence than to you, whom he emphatically styled "his right hand." Attached to astronomy, but unable to maintain your family upon the *miserable* pittance allowed you by the government, we see you observing all day and computing all night. As an assistant of the Royal Observatory, I have only to say,—Go on as you have begun. But if a trust higher in the scale of importance awaits you, remember, sir, that you have *now* a character

* The President's.

to maintain; for your name, but a few years since confined to the narrow limits of a country village, is now known throughout Europe; and that too by your own exertions. Receive this medal, sir, as a pledge of our esteem—as, indeed, the highest honour we have to offer. May it stimulate you to fresh exertions in the cause of your favourite science; and on your return from India to your native home, may the Astronomer of Madras be as honourably distinguished, as is this day the Assistant of the Royal Observatory.

(*The President then resumed his address to the Members, as follows:*—)

The second medal has been adjudged to Professor Encke, for the *Berlin Ephemeris* which bears his name. Experience has long shewn, that an astronomical ephemeris is almost as necessary an appendage to an observatory as are the instruments themselves; accordingly we find that some one, more or less perfect, has been in the hands of every astronomer, since astronomy has been pursued in a systematic manner. The first which appears in this country at all deserving the name of an astronomical ephemeris was that of Vincent Wing, and was used by Flamsteed: it, however, was very imperfect, and Flamsteed, whilst at Derby, transmitted to the Royal Society supplements to it, containing notices of phenomena not inserted in *Wing's Ephemeris*, and which were published from time to time in the *Philosophical Transactions*. La Caille, about the year 1755, proposed one upon a larger scale; but in 1767, on the recommendation of Dr. Maskelyne, the Board of Longitude of Great Britain published the *Nautical Almanac and Astronomical Ephemeris*, Dr. Maskelyne himself taking the superintendence of it. Its object was evidently twofold, since it contained, even when first published, much information not wanted by the astronomer, and still *more* not required by the seaman. The *Connoissance des Tems* also was published much in the same style, and was, as well as the *Nautical Almanac*, a manual not only for the seaman, but also for the astronomer. The *Berlin Ephemeris* was purely astronomical, but, like the *Connoissance des Tems*, contained, in the shape of additions, much valuable astronomical information, inserted by its highly respected editor, the much-lamented Bode. But the *Connoissance des Tems*, compared with the *Nautical Almanac*, had so fallen into disrepute, that, in the year 1795, Grégoire, now Evêque de Blois, in the name of the Committees of Marine, of Finance, and of Public Instruction, proposed to the National Convention the establishment of a Board of Longitude, in imitation of the British Board, and to which should be confided the publication of the *Connoissance des Tems*. From that time to the present it has been published with greater regularity, and in general about the same time as the *Nautical Almanac*; for, from some cause or other, the latter has not appeared so many years in advance as in the times of Maskelyne. Considering that the work is sometimes wanted for long voyages of

discovery, its publication 3 or 4 years in advance, instead of 2½ years, as at present, would certainly be desirable. From the time of Maskelyne's editing the *Nautical Almanac* till his decease, it gained the approbation of his countrymen and the eulogies of foreign astronomers. La Lande, speaking of it, says, "*On a fait à Bologne, à Vienne, à Berlin, à Milan; mais le 'Nautical Almanac' de Londres est l'éphéméride la plus parfaite qu'il y ait jamais eu.*"

On the death of Maskelyne, the superintendence of it passed into the hands of "irresponsible" persons, and the character which it had so long sustained was lost. Compared with corresponding productions of other countries, it was not only inaccurate but incomplete. Astronomical knowledge was progressive; but the *Nautical Almanac* remained not only stationary, but retrograded. To restore it to its former rank, a new Board of Longitude was formed, and the superintendence of the Almanac was confided to the Secretary of the Board. To retrieve the character of a work which, from holding the highest rank in the ephemerides of Europe, had descended below mediocrity, was no easy task; but it is due to the memory of that eminent person to acknowledge, that the first volumes published under his superintendence did much to restore its character for accuracy. Other ephemerides, however, having, in an astronomical point of view, got the start of it, sustained their superiority; and there is scarcely an observatory in the country upon whose desks have not been found, for several years past, the ephemerides of France, of Berlin, and of Milan. As a small addition, a supplement has been recently published; this, however, gets into circulation not till its year is actually commenced, and therefore is comparatively of little use. Under these circumstances, so injurious to the astronomical character of the country, many have been the discussions relative to the *Nautical Almanac*, and the individual who has the honour to address you has not been unconcerned in them. His animadversions may have been occasionally severe, but he hopes never unjust;—they were intended to convince, not unnecessarily to wound. For the individual with whom he had the misfortune to differ, he entertained the highest respect; and by no one even of his scientific friends, was his premature removal more keenly felt than by him, who never differed from him but with regret. His acquirements were of no common order; and whatever may be our opinions of his superintendence of the *Nautical Almanac*, all suffrages will unite in pronouncing him an ornament to his country.

Since the decease of Dr. Young, the superintendence of the Almanac has been transferred to the Astronomer Royal, and the volume for 1832 has just been published under his direction. No important alteration distinguishes it from its predecessors. Almost on the same day appeared the corresponding volume of the *Connoissance des Tems*. The former gives us no notice of improvements contemplated for future volumes; the latter promises

some important additions. I have, however, the satisfaction of announcing to the Society the following message from the First Lord of the Admiralty, transmitted to me through the Hydrographer; namely, "that the Admiralty has actually ordered some additions to the Almanac for 1833, and has it in contemplation to order further additions to that for 1834." What these additions are, it has not been thought proper to divulge, at least to me; let us therefore hope that they will be worthy of the country, and that ere long the *Nautical Almanac and Astronomical Ephemeris of Great Britain*, rising like a phœnix from its ashes, shall be as much superior to Encke's, as Encke's is now superior to it. That, however, will be no easy task: Encke, whose name stands already in the list of those to whom our medal has been *before* adjudged, is no ordinary rival. Well knowing what is wanted in an observatory—skilled in practice—profound in theory—and living under a government by which science is *eminently* encouraged—he has given to us an ephemeris, which is invaluable. To enter into its individual merits would far exceed the time allowed me; suffice it to say, that for every purpose of astronomical investigation, its materials are sterling, and its arrangement excellent. With it, an observatory scarcely wants a single book; without it, every one.

(*The President then, addressing Mr. Baily, said:*—)

Mr. Baily,—To no one can I confide this medal with more propriety than to you; for no one, more than you, knows the importance of our associate's labours. Transmit it to him as a second badge of our regard; and tell him, that for his Ephemeris we are under obligations to him, which we never can repay.

List of Officers for the ensuing year.

President: James South, Esq. F.R.S. L. & E. M R.I.A. & F.L.S.—*Vice-Presidents:* Captain F. Beaufort, R.N. F.R.S.; Olinthus G. Gregory, LL.D. *Prof. Math. Roy. Mil. Acad. Woolwich;* J. F. W. Herschel, Esq. M.A. F.R.S. L. & E. F.G.S. & M.R.I.A.; Edward Troughton, Esq. F.R.S. L. & E.—*Treasurer:* Rev. William Pearson, LL.D. & F.R.S.—*Secretaries:* Rev. Richd. Sheepshanks, M.A.; Lieutenant William S. Stratford, R.N.—*Foreign Secretary:* Captain W. H. Smyth, R.N. F.R.S. & A.S.—*Council:* George Biddell Airy, Esq. M.A. *Plum. Prof. Ast. Univ. of Camb.;* Hon. Lord Ashley, M.P.; Charles Babbage, Esq. M.A. F.R.S. *Lucas. Prof. Math. Univ. of Camb.;* Francis Baily, Esq. F.R.S. L.S. & G.S. & M.R.I.A.; Augustus De Morgan, Esq. B.A.; Davies Gilbert, Esq. M.P. *Pres.* R.S. F.L.S. & G.S.; John Lee, Esq. LL.D.; John William Lubbock, Esq. M.A. & F.R.S.; John Lewis Tiarks, Esq. F.R.S.; John Wrottesley, Esq. M.A.

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

March 12, 1830. No. 26.

THE following communications were read:—

1. *Extract from a Letter of Professor Harding to Dr. Tiarks, dated Gottingen, December* 19, 1829.

"I observed the occultation of *Aldebaran* on the 9th of December, and the sky being perfectly clear, I obtained the moments of immersion and emersion with extreme precision. The first creeping out of the star at the emersion was easily perceived, by the contrast of its red light with the white light of the moon's limb, and I think that the observation of the emersion is as accurate as that of the immersion. I devoted all my attention to the observation, with a view to the well-known phenomenon of the star's remaining visible some seconds on the moon's disc, which has been repeatedly observed in this star, and which I have myself seen several times. I remained, at the immersion, as well as at the emersion, 10 seconds before the telescope without turning my eye off, but nothing of the kind was seen."

Occultation of α Tauri, Gottingen, Dec. 9, 1829.

	h	m	s	
Immersion	23	37	33,3	} Sidereal time.
Emersion	0	37	58,3	

2. "On Mr. Pond's recent catalogue of 720 principal stars." By Francis Baily, Esq. In this communication, the author confines himself to an examination of the *differences* between the values in Mr. Pond's catalogue and the catalogue published by this Society in the second volume of their Memoirs. It is well known that this last-mentioned catalogue was deduced from the catalogues of Bradley and Piazzi, agreeably to the rigid formula laid down by M. Bessel for that purpose: and it is evident, from an inspection of that formula, that any proper motion which is indicated by a comparison of the catalogue of Bradley or Piazzi, or any error in either of those catalogues, is increased two-thirds in amount when the star is thus brought up to the year 1830; and, consequently, that the whole weight of such accumulated difference will fall on the Society's catalogue. Yet, notwithstanding this contingency, it appears that there are not more than 30 stars in Mr. Pond's catalogue where the difference in right ascension may not be eliminated by a correction of less than half a second (in time), nor more than 14 where the difference in north polar distance may not be

eliminated by a correction of a quantity less than 7 seconds (in space), to the catalogues of Bradley or Piazzi; within which limits even the best modern catalogues do not always agree.

The author then examines, and compares with various catalogues, the cases of these 30 stars in right ascension, and 14 stars in north polar distance; and the result of his inquiry is, that the differences (wherever they exist) are, with only one exception, to be attributed to errors in the catalogues of Bradley, Piazzi, or Pond. The exception here alluded to is a very remarkable one: for not only was the error committed by the two separate and independent computers who formed the catalogue; but the author himself fell into precisely the same mistake (even as to every figure) in repeating the calculation.

The author concludes by remarking, that hitherto it has been reasonably inferred that we could compute the place of a star with great accuracy for any distant period; but that the recent catalogue of Mr. Pond has dispelled this illusion, and has shewn most clearly, that, owing to the imperfections of some one or other of the catalogues (from which even the catalogue of Mr. Pond is not exempt), the result cannot be depended on for that degree of accuracy which the present state of astronomy demands; and that, in order to attain the utmost perfection, the catalogues ought to be re-examined, re-observed, re-computed, and re-compared every 20 or 30 years.

The epoch of Flamsteed's catalogue is 1690; and just 120 years afterwards appeared the catalogue of Bradley, the work of a foreign hand. Since the time of that indefatigable astronomer (a period of nearly 70 years) the subject has been almost entirely lost sight of in this country, as no materials have been collecting for a similar production till the late determination of Mr. Pond to turn the immense powers in his possession to this limited revision of the heavens.

3. "On the method of computing the longitude from an observed occultation of a fixed star by the moon, by Edward Riddle, Esq."

In the method of computing recommended in this paper, the usual data are to be taken from an ephemeris, for the estimated Greenwich time of the observed occultation; and setting aside refraction, by which the star and the apparent place of the lunar disc where the occultation takes place are equally affected, the apparent place of that point is the same as the true place of the star. Now, if from the true place of the point of occultation two perpendiculars be let fall, one on the meridian passing over the star, and the other on that passing over the true place of the moon's centre, then the rectangle under the *cosecant* of the polar distance of the point of occultation, and each of these perpendiculars, will give, respectively, the measure of the parallax in right ascension, and that of the difference between the right ascension of the point of occultation and the moon's centre.

The former of these being added to the star's right ascension *when* the occultation is west of the meridian, and subtracted from

it when east, and the latter added at an emersion and subtracted at an immersion, the result is the right ascension of the moon's centre; whence the Greenwich time may be inferred from an ephemeris.

The author investigates two sets of formulæ for making the calculation, and gives skeleton forms for computing, with tables for finding the geocentric latitude, and adapting the moon's equatorial parallax to the latitude of the place of observation; and three examples from observations of the occultation of *Aldebaran*, October 15th, 1829, are worked out at length.

Putting M for the moon's horizontal parallax, L for the geocentric latitude, P for the star's polar distance, H for its horary angle, and letting fall a perpendicular from the reduced place of the zenith on the star's polar distance, Mr. Riddle computes directly the two segments into which this perpendicular divides the polar distance; and calling the segment adjacent to the pole, A, and that adjacent to the star, B, it is shewn in the first set of formulæ that the parallax in polar distance = M . *cos* L . *cosec* A . *sin* B . *cos* H; and in the second, after computing directly by Napier's analogies the angle S at the star formed by the zenith and polar distances, it is shewn that the parallax in polar distance = M . *cos* L . *sin* H . *cot* S.

Hence the true polar distance of the point of occultation is found; and thence, by a short process, the difference between the right ascensions of the star and the moon is obtained. When the time deduced from the moon's right ascension, computed in this manner, differs materially from the estimated Greenwich time, the difference between the right ascension of the point of occultation and that of the moon's centre, is directed to be recomputed with the moon's polar distance, taken for a minute or two earlier or later, and a new corresponding Greenwich time found; and a formula, depending on simple proportion, is then given, by which the true Greenwich time may be inferred with sufficient exactness.

In concluding, Mr. Riddle shews how, from the time at which the moon and the star have the same right ascension, as given in the elements for computing the occultations in the *Nautical Almanac*, and the horary motion in right ascension, the preceding computations may be made available to determine directly the time at Greenwich, without any reference to the moon's right ascension.

J. NOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

April 7, 1830. No. 27.

THE following communications were read:—

1. Observations of the Planets made at the Imperial Observatory of Vienna, in the year 1828, by J. J. Littrow.

In this paper Professor Littrow communicates the *apparent* places of the planets in R. A. and N. P. D., as observed on the meridian of Vienna, corrected for refraction and parallax. The results are compared directly with Schumacher's ephemeris, and the errors of the tables ascertained.

	Limits of Errors of the Tables.			
	R.		N.P.D.	
	s	s	″	″
58 obs. of Venus..	+0,22	−0,98	+18,7	− 5,8
46 —— Mars....	+0,89	−0,32	+ 4,5	−24,0
5 —— Vesta...	....	....	....	....
44 —— Jupiter..	+0,42	−0,72	+ 2,6	− 6,8
20 —— Saturn..	+1,35	....	....	− 7,6
35 —— Uranus..	....	−1,42	....	− 9,8

The errors are to be applied, with their proper signs, to the *tabular* places, in order to obtain the *true* and *observed* places. The errors in the greater number of planets have periodic values, which are not always small; and, consequently, the Tables, or rather the elements from which they have been constructed, are susceptible of considerable improvement. This appears to be eminently the case with *Uranus*, for which the differences in R. A. are very great.

Two catalogues of the N.P.D. of Bessel's 45 fundamental stars follow; the first reduced to 1829, as determined by the observations made in the year 1828, and compared with Bessel; the second reduced to 1830, as determined by the mean of three years' observations, (during which time the meridian circle has been in use), compared with Bessel, and also with the fundamental catalogue of the Astronomer Royal, in the *Nautical Almanac* of 1830. Professor Littrow remarks, that the observations of Vienna fall generally between those made at Greenwich and those at Konigsberg. The

differences between the three observers are, however, greater than might be wished, and they are remarkably large in *α Aquarii*, *α Canis minoris*, α^2 *Capricorni*, *α Pegasi*, *α Persei*, and *α Virginis*.

2. Observations of Occultations of Stars by the Moon, at Mr. South's Observatory, Kensington.

1830.		Sidereal Time. h m s	
Mar. 28.	ν^1 Tauri.....	Im. 7 38 2,75	mean of 4 observers. No projection.
	ν^2 Tauri.....	Im. 7 45 23,49	mean of 5 observers. Ditto.
*	R.A. $4^h\,19^m\,7^s$ / N.P.D. 74° 14′	Im. 7 54 10,35	mean of 2 observers.

Lord Ashley, with the 19-feet achromatic, and Mr. South, with the 5-feet equatorial, saw the star projected on the moon's disc by a quantity equal to its own diameter. Five other observers saw no projection.

* { R.A $4^h\,21^m\,40^s$ / N.P.D. 74° 34′ } lost at $9^h\,22^m\,23^s,41$, near to the illuminated cusp; doubtful whether occulted or no.

85 *Tauri*. Im. $9^h\,26^m\,26^s,41$. Lord Ashley saw the star distinctly within the moon's disc: 5 other observers did not notice any projection.

		h m s	
April 5.	*τ Leonis*.	Im. 8 6 13,0	by Mr. Stratford.
		Em. 9 23 3,5	

3. *Extract of a letter from Charles Perkins, Esq. to the President:—*

"I observed most of the occultations last night (March 28). My friend Mr. Holland was with me, and we both considered the stars 99 Tauri, and Piazzi IV. 102, to have been visible on the moon's disc. Each observer used a 42-inch achromatic with $2\frac{3}{4}$ aperture, mine with a power of 120, and Mr. Holland tried one of his own eye-pieces, the power of which he estimated at 336. With this he observed the star distinctly, and the moon's dark limb well defined."

4. On a method of ascertaining any inaccuracy in the formation of the Pivots of Transit Instruments, &c., or any subsequent derangement in their shape. By Lieut. Peter Lecount, R.N.

On visiting the workshop of M. Repsold of Hamburgh, Lieut. Lecount's admiration was excited by the accurate manner in which the German artists execute the steel pivots for their astronomical instruments. The apparatus for detecting flexure used by M. Repsold consists of a series of inverted levers; and on considering this and Reichenbach's *lever of contact*, Mr. Lecount was led to conceive that both of these might be advantageously replaced by a single instrument, on the construction of the wheel pyrometer.

If we conceive a cylindrical pivot to rest either in a Y or upon a smooth plane, and a flat piece to be applied to its upper surface, it is clear that, when the pivot is turned round, any deviation in it from the circular form will cause a motion up or down in the flat piece; and if this be connected by rack-work with the circum-

ference of a circle, which turns freely round its centre, a rotatory motion will be communicated to the circle. This may be readily magnified to any extent that may be deemed advisable; and, in the opinion of Mr. L., an apparatus thus constructed will have the same advantages over those employed by Repsold and Reichenbach that the modern wheel pyrometer possesses above the old system of combined levers.

5. "Fourth Series of Observations with a 20-feet Reflector, containing the mean places and other particulars of 1236 Double Stars, as determined at Slough in the years 1828 and 1829 with that instrument (the greater part of them not previously described). By J. F. W. Herschel, Esq."

The observations of the places in right ascension and polar distance of all the double stars observed by the author between the 17th of March, 1828, and the end of 1829, with the 20-feet reflector, at Slough, accompanied with descriptions, and, in the majority of cases, with micrometrical measures of their angles of position, are communicated in this paper, arranged in order of right ascension for convenience of reference, and form a continuation of his previous communications on the same subject. The total number of double stars catalogued in this paper is 1263, of which nearly 1000 are new; the remainder have been already before observed, and belong to the catalogues of Sir William Herschel, Mr. South, Mr. Struve, &c. They are all, however, arranged in one list, the new ones only being designated by numbers continued onwards from 1000, the last of the preceding catalogues. Among the stars observed occur several of those which are now well ascertained to have an angular motion round each other; such as η *Cassiopeæ*, γ *Virginis*, and 61 *Cygni*. Of these, the author remarks that the two latter have changed quadrants, and passed from the northern to the southern halves of their orbits, since their last measurement by Mr. South in 1825; that the same is true of another very remarkable binary star, σ *Coronæ*, which is now far advanced in the south following quadrant; and that η *Cassiopeæ* is on the point of making the same decisive change in the same direction, and will probably have completed it before the year 1835; thus rendering the decade 1825–1835 remarkable as a chronological epoch, since a similar concurrence will not take place again for a great many thousands of years.

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

May 14, 1830. No. 28.

THE following communications were read: —

1. On an appearance of divisions in the exterior ring of Saturn. By Captain Henry Kater, Vice President and Treasurer of the Royal Society.

The observations which form the subject of this paper were made in the years 1825 and 1826, and remained unpublished from a wish on the part of the observer to witness the appearances again, — but bad health and the uncertain state of the atmosphere in this country have hitherto prevented him.

The planet Saturn has been much observed by Captain Kater, for the purpose of trying the light, &c. of his telescopes, for which the ring and satellites are good tests. The instruments which were employed in the present investigations were two Newtonian reflectors, — one, supposed by Watson, of 40 inches focus, and $6\frac{1}{4}$ aperture; and another, by Dollond, of 68 inches focus, and $6\frac{3}{4}$ aperture. The first, under favourable circumstances, gives a most excellent image; the latter is a very good instrument. The following are extracts from the author's journal.

"*Nov.* 25, 1825. — The double ring beautifully defined, perfectly distinct all round, and the principal belts well seen. I tried many concave lenses, and found that the image was much sharper than with convex eye-glasses, and the light apparently much greater. Dollond, 259 the best power; 480, a single lens, very distinct.

"*Nov.* 30. — The night very favourable, but not equal to the 25th. The exterior ring of Saturn is not so bright as the interior, and the interior is less bright close to the edge next the planet. The inner edge appears more yellow than the rest of the ring, and nearer in colour to the body of the planet.

"*Dec.* 17. — The evening extremely fine. With Dollond I perceived the outer ring of Saturn to be darker than the inner, and the division of the ring all round, with perfect distinctness; but with Watson I fancied that I saw *the outer ring separated by numerous dark divisions extremely close, one stronger than the rest dividing the ring about equally.* This was seen with my most perfect single eye-glass power. A careful examination of some hours confirmed this opinion.

"*Jan.* 16 and 17, 1826. — Captain Kater believed that he saw the divisions with the Dollond, but was not positive. Concave eye-glasses found to be superior to convex.

"*Feb.* 26, 1826. — The division of the outer ring not seen with Dollond.

" *Jan.* 22, 1828.—The evening remarkably fine, and the same appearances shewn as on the 30th November, 1825, but no divisions seen in the outer ring. I am, therefore, the more persuaded that they are not permanent." With the Dollond.

On the 17th December, when the divisions were most distinctly seen, Captain Kater made a drawing of the appearance of Saturn and his rings. The phenomena were witnessed by two other persons on the same evening, one of whom saw several divisions in the outer ring, while the other saw one middle division only; but the latter person was short-sighted, and unaccustomed to telescopic observations.

It will be remarked, that these divisions were not seen on other evenings, which yet were considered very favourable for distinct vision.

It seems that the same appearances were seen by Mr. Short, but the original record of his observations cannot be found.

In *Lalande's Astronomy* (third edition), article 3351, it is said, " Cassini remarked that the breadth of the ring was divided into two equal parts by a dark line having the same curvature as the ring, and that the *exterior* portion was the less bright." (*Mém.* 1715 p. 13.) Short *told* me that he observed still more singular phenomena with his large telescope of 12 feet.

The breadth of the ansæ, or extremities of the ring, was, according to him, divided into two parts,—an inner portion without any break in the illumination, and an outer, divided by several lines concentric with the circumference; which would lead to a belief *that there are several rings in the same plane.*

Delambre and Biot severally state, that Short saw the outer ring divided, probably on the authority of Lalande cited above. There is a note to the same purpose in Brewster's edition of *Ferguson's Astronomy*, but without reference to the source from which it is taken.

In December 1813, at Paris, Professor Quetelet saw the outer ring divided, with the achromatic telescope of 10 inches aperture, which was exhibited at the exposition. He mentioned this the following day to M. de la Place, who observed, that " those, or even more divisions, were conformable to the system of the world."

But, on the other hand, the division of the outer ring was not seen by Sir William Herschel (*Phil. Trans.* 1792), nor by Mr. Herschel in 1826, nor by M. Struve in the same year; and on several occasions when the atmospheric conditions were most favourable, it has not been seen by Captain Kater.

" It has been remarked by Sir William Herschel, by M. Struve, and by most persons who have observed Saturn, that the exterior ring is much less brilliant than the interior. May not this want of light in the outer ring arise from its having a very dense atmosphere? and may not this atmosphere in certain states admit of the divisions of the exterior ring being seen, though, under other circumstances, they remain invisible?

" With respect to the form of the edge of the inner ring of

Saturn next to the planet, the appearance under favourable circumstances is such as to leave no doubt on my mind of its being rounded."

2. Occultations observed at Biggleswade with the Society's Wollaston Telescope. By T. Maclear, Esq., Member of the Society.

The observations consist of 32 immersions and 15 emersions of stars behind the moon, from 8th August, 1829, to 3d May, 1830, given in sidereal time, with the circumstances of the phenomena.

As the value of such observations depends mainly upon the accuracy with which the time is known, Mr. Maclear gives a full description of the means employed by him for that purpose. His transit instrument is by Mr. Thomas Jones, of 30 inches focal length, and $2\frac{1}{2}$ aperture. This was placed in the meridian last September, and the azimuth screws have not been touched since. The position is ascertained by the transits of circumpolar stars, and the observations corrected for the deviation thus shewn. The west end was left with a small positive error; and the altitude screws have not been altered. The inclination of the axis is ascertained by the level, and the proper correction applied.

A meridian mark by Mr. Robinson, soldered into a well-fixed stone, and viewed through a lens of 34 feet focus, serves as a convenient and constant check upon the position of the instrument. A small dot near the mark serves for correcting the error of collimation; and when the instrument is thus corrected, no error can be detected by the transits of circumpolar stars.

The pivots of the transit were examined in the manner recommended by Professor Airy, and the difference between their radii ascertained. This is not the same at all altitudes; and it has been found necessary to obtain it for every 10°. Mr. Maclear shews how the value of this correction is to be obtained, and applies it to a case of Polaris.

"It may be remarked, that I have generally used a high power on the telescope; I have used what best suits my eye according to the state of the atmosphere, and the magnitude of the stars which undergo occultation. I first sweep the moon's apparent path with power 36, which comprehends a field of view sufficient to make allowance for the change of place produced by motion in N. P. D., and alteration of parallax. I next minutely re-examine with 75. This power is proper for observing stars down to the ninth magnitude, during the first and last six days of the lunation; but for magnitudes from 6 to 10, when the limb is bright, I employ a single eye-piece, power 160. It diminishes the moon's lustre, and renders the stars very distinct. The latter, when in contact with the limb, appear like those small lunar mountains seen during libration."

For the convenience of astronomers who possess telescopes mounted equatorially, Mr. Maclear recommends that the angular distance of the occulting point should be reckoned from the place where the circle of declination cuts the moon's disk.

	m	s	
The longitude of Mr. Maclear's Observatory by the trigonometrical survey	1	2,9	West.
By the immersion and emersion of Aldebaran, Oct. 15, 1829, compared with corresponding observations at the Royal Observatory	1	2,97	

	°	′	″
The latitude deduced from the survey ..... =	52	5	25·23
By a mean of 10 circum-meridian observations with a sextant, and 3 with Troughton's reflecting circle, Mr. Maclear found.....	52	5	25·3

3. On the Comet discovered at Marseilles in the constellation Equuleus. By James South, Esq. President.

"Our indefatigable associate, Monsieur Gambart, having had the kindness to transmit me the approximate place of this comet, discovered at Marseilles on the 21st of last month, I had the good fortune to find it on the evening of the day on which his communication reached me; and the following observations of it will, I trust, not be unworthy the Society's notice.

FIVE-FEET EQUATORIAL.

1830.	Sidereal Time.			Comet's R.A.			Comet's Decl.		
	h	m	s	h	m	s	°	″	′
May 1	17	50	46	21	14	34	+16	27	58
2	16	54	37	21	14	56	16	58	49
3	17	30	35	21	15	21	17	30	2
11	16	0	0	21	17	44	20	56	25
13	16	21	0	21	18	2	21	37	57

"In the 5-feet equatorial the comet is nearly circular, and about two minutes in diameter; its nucleus is well defined, and bears magnifying power better than that of any comet I have seen; although the moon's light was very considerable, it was found on the 1st of May without the slightest difficulty. On the moon's setting, its nucleus could be bisected with the wire of the 5-feet equatorial without difficulty. No tail could be perceived with that instrument; but at half-past two in the morning (civil reckoning), with powers 130 and 346, the 20-feet achromatic shewed a faint tail diffused across the field, the comet being placed at its circumference.

"On the 3d, at a quarter before three in the morning, with the 20-feet, the nucleus was well shewn with 130, 346, and 490; with 1000 it could be seen at moments, but with 1126 and higher powers it became an apparently uniform luminous cloud.

"This morning (May 14), from a quarter past one till a quarter past two, I viewed it with the 20-feet achromatic. With a power of 60, made expressly for the purpose by Messrs. Tulley, its nucleus was a brilliant point; with 130 it resembled the disk of Spica Virginis when seen with the 5-feet equatorial through slight haze;

with 252 it was elegantly defined; with 346, 430, and 490, at times beautiful; with 663, its limb sufficiently distinct to admit of micrometrical measurement; with 773, disk still visible; with 928, perceptible only by glimpses; and with 1126, 2440, and intermediate powers, a mere luminous cloud.

"With 252, a tail of extreme tenuity could be perceived; and with the higher powers, the luminous part of the comet being placed just out of the field, its direction could be at times detected. It is invisible to the naked eye; probably, however, in consequence only of the moon's light. Morning beautiful, heavy dew, and the object-glass, when the observations were concluded, had on it just sufficient dew to destroy its polished appearance.

4. Notice of the performance of the 20-feet achromatic, May 14, 1830.

"*Georgium Sidus.*—At half-past two, placed the 20-feet achromatic on the Georgium Sidus; saw it with 346, a beautiful planetary disk; not the slightest suspicion of any ring, either perpendicular or horizontal; but the planet three hours east of the meridian, and very low. Morning beautiful, but moonlight very strong, and the moon within three degrees of the planet.

"*Jupiter* (at a quarter before three), with 252 and 346, literally covered with belts, and the diameters of his satellites might have been as easily measured as himself. One came from behind the body, and the contrast of colour with that of the planet's limb was striking.

"*Mars* (near three o'clock).—The contrast of light in the vicinity of the poles very decided; on the 3d, several spots on his body, well and strongly marked. This morning, that about the south pole seems to overtake the body of the planet, and gives an appearance not unlike that afforded by the new moon, familiarly known as 'the old moon in the new moon's arms.'

"*Saturn* has been seen repeatedly with powers 130 to 928, under circumstances the most favourable; but not any thing anomalous about the planet or its ring could even be suspected."

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

June 11, 1830. No. 29.

THE following communications were read: —

I. Observations and remarks made on a passage from New South Wales to England, by Charles Rumker, Esq., Member of the Society.

1st. A short table, with directions for ascertaining the time approximately by the position of the constellation of the Cross. For a rough estimation, it may be remembered that the Cross is vertical above the pole at midnight 21st March, and vertical below the pole at midnight Sept. 23rd.

2nd. Observations of the variation and dip of the needle, made on the passage home in 1829, round Cape Horn: and,

Observations of the variation and dip, made on the passage outwards by Sir Thomas Brisbane and Mr. Rumker, in 1821, round the Cape of Good Hope.

In these observations, which are very numerous, the date, latitude and longitude, the altitude of the sun when his azimuth was observed and his magnetic azimuth, the variation deduced, the place of the compass and the ship's course, are given. Mr. R. remarks, "that amongst observations made at sea which are of a permanent value, those of the variation and dip of the needle occupy the first rank, whether with respect to their use for navigation, or establishment of magnetic laws. Indeed, I think the method of ascertaining the longitude by a variation chart has been too readily abandoned. It should be remembered, that the object to be found, viz. the longitude, is, at the same time, the principal element for the construction of the chart, and was at that time ill known, being collected from the log-books of ships, which, owing to the then more precarious means of ascertaining it, were much out in their reckoning. The annual change in the variation was also not determined. I must allow that there are tracks where this method becomes impracticable, where the magnetic meridians run parallel with the equator; but over the whole of the Atlantic, as well as in the torrid zone of the Pacific, they are parallel to the terrestrial meridian, so that the change in the variation is as rapid as the longitude, and nothing can be imagined more convenient than to take the longitude from the ground we cross.

"The principal objection that can be started is undoubtedly the effect produced in the variation by changing the place of the

compass in the vessel, or by an alteration in the course. But this effect is less in proportion to the size of the vessel, and less in small merchantmen than in men-of-war carrying ordnance and ammunition; and it is these smaller vessels which, less likely to be provided with chronometers, will have occasion for the method. Besides, when an evil is once known, the remedy cannot be far off; and it is in high latitudes, where the dip is great, that the compass is much acted upon by surrounding objects: not so in the equator, where the magnetic force is concentrated in the horizontal plane.

"I may remark, that the great circle through Port Jackson and Cape Horn passes within 17° of the Pole; and although ships cannot approach it so near on account of the ice, it would shorten the distance to run down, at first, upon a S.S.E. course to latitude 58°, at which they must arrive to double the Cape. We saw no ice, and the lowest stand of the thermometer was 43°: we had constantly fresh westerly winds, which prevail here, with thick foggy weather."

3rd. Currents.

"The waters of the Pacific being supposed higher than those of the Atlantic, I expected an easterly current on approaching Cape Horn, but I could discover none. Near the northern coast of the Brazils and Guiana we experienced strong currents to the west, in conformity with Humboldt's theory of an indraft into the Caribbean Sea, occasioned by an equatorial current." Mr. R. gives a table of comparison between the ship's place by observation and that obtained by the log, with the drift and force of the current for twenty-four hours.

Mr. R. had no opportunity of making any geographical observations, except verifying the situation of Rat Island, as observed by Sir T. Brisbane and himself in 1821. He had reason to believe that the longitude of Fernando de Norunha is 32° 16′ W., as determined by Sir Thomas and himself, rather than 32° 35′, as stated in the charts. He would direct the attention of hydrographers to the errors in the position of the Brazilian coast, to which, perhaps, the currents have given rise.

"The greatest advantage which a chronometer affords is that of rendering permanent the use of lunar observations, (which would otherwise be as transient as the ship's place,) by deducing from every set simply the error from the *mean* time at Greenwich corresponding to the *true* distance, without any regard to the temporary longitude of the ship. These observations can be made at any time of the day, whether the sun rises slow or fast. Assuming, then, the mean of the errors found on several days as the error corresponding to the mean day, you obtain, twice a month, epochs for the errors of the chronometer, with its rate during the interval, which will enable you at any time to find your longitude *apparently* by chronometer, but, in *reality*, by the mean of numerous lunar observations."

" Thus I found—

1829.		Chron. fast on mean Greenwich time.			Daily Rate.
		h	m	s	s
January	12·0	1	25	43,2	15,0
	26·0	1	30	3,0	14,5
February	10·0	1	33	41,0	17,7
	27·8	1	38	56,5	14,6
March	11·5	1	41	47,5	13,9
	26·8	1	45	19,7	15,5
May	7·7	1	56	3,2	14,3
June	9·7	2	3	55,7	

" A gaining rate of 5ˢ had been given to this chronometer by the watchmaker who had charge of it at Sydney. Could its being kept on shore and on board make so much difference in the rate?"

" The remaining uncertainties of the tables of Jupiter, Venus, Mars, and Saturn, are really inconsiderable in comparison with the degree of accuracy required for nautical purposes; whereas it is the light and distinctness of the object observed that steadies the hand of the observer, and enables him to keep it in the field of the telescope during the violent motion of the vessel, which is the greater the smaller the vessel, and, consequently, the less the probability of its being provided with a chronometer. The observations of the distances from fixed stars have, in a rough sea, difficulties which disappear in observations of the planets, which may, in strong currents near land, be the means of saving the lives of the crew."

4th. " *Sargasso Weeds.*—In the north Atlantic ocean, coming from the south, you fall in about the tropic with the Sargasso weeds, collected in narrow lines extending in the direction in which the trade wind blows, that is, E.N.E. and W.S.W., and the eye cannot see the end of them on either side of the vessel. These lines run constantly parallel to each other, and the nearer you come to the middle of the Sargasso Sea the thicker it is strewed with weeds, and the closer the lines approach to one another, being in some places but fifteen feet asunder. Homebound ships have a better opportunity of observing these lines, as they cross them nearly at right angles, and can trace their continuation more conveniently on both sides, observing one line after another in rapid succession.

" These weeds occupy the zone from about 20° to 35° north latitude, which may, however, differ according to the longitude in which you cross it. Towards the zone's northern extreme the weeds are less regularly formed in lines, which may arise from their being less methodically acted upon by the trade-winds that seem to occasion their order. They have been termed gulf-weeds by sailors, who believed them to be driven out of the gulf by the

Florida stream; nor is this opinion entirely refuted by the experience that they are rarely met with in the gulf. For the weed swimming on the surface of the Atlantic is withered, decayed, and incrusted with salt, which proves the time it has been exposed to the sun, and is of a brownish-yellow colour, whilst you rarely meet with a green bunch: that, being heavier on account of its higher state of vegetation, swims several feet below the surface. It is true that not with certainty can any roots, thicker branches, or stems, be perceived, wherewith they might have adhered to rocks or the ground: nevertheless, as these weeds abound with animals that do not live upon the surface but inhabit the bottom of the sea, such as crabs, shrimps, barnacles, conchilias of all descriptions, and serpents, I have no doubt but that they originated in a shallow basin of water, out of which they were swept by the force of a current along the bottom, until the heavier vegetable fluid being exhausted, they rose to the surface. Moreover, they are never seen near the European or African coast, but most plentifully found about the entrance of the gulf."

II. A letter from F. Hartmann, lieutenant of engineers, to J. F. W. Herschel, Esq., describing an instrument constructed for him, according to his own directions, by M. Hohnbaum, optician, of Hanover.

It is not very easy to understand the plan of this instrument without a drawing, but it would seem that Lieut. H.'s theodolite consists of a transit telescope resting upon two pillars sufficiently high to allow of the free revolution of the telescope; the whole placed upon a circle which moves freely in azimuth, furnished with a repeating apparatus. A divided circle is attached to each end of the transit axis, one of which has a vernier apparatus similar to that of the large Reichenbach meridian circles, the other serves to balance the former, and to set the telescope to any zenith distance required. It will be seen that, by this combination of azimuthal and vertical motion, Lieut. H. is enabled to *repeat* as with the circle of Borda.

The weight of the circle, &c. is eased by friction-rollers: the object-glass and eye-pieces are by Fraunhofer, and of great excellence, and the vertical and azimuth circles are about sixteen inches in diameter.

III. On the rectification and use of the equatorial. By M. Kreil.

This paper is intended to serve as a continuation and practical application of one by Professor Littrow on the same subject, published in the *Ast. Soc. Memoirs*, vol. ii. p. 45.

In Professor Littrow's memoir only four errors were considered; the displacement of the pole of the instrument in *altitude* and in *azimuth*, and the errors of the verniers of the declination and of the hour circle. The Professor conceives that the artist has secured the other important conditions, viz. that the axis of the telescope and the polar axis shall both be in the plane, or parallel to the

plane of the declination circle. In Reichenbach's large equatorials this circle is fixed so as not to admit of reversion, or (as it would seem) of the application of a level to the pivots of its axis; and the first part of M. Kreil's memoir is employed in ascertaining the amount of any derangement in this part of the instrument by *observation* alone.

The first of these errors (which is similar to the error of collimation in a transit) causes the star to be observed in a small circle parallel to the plane of the declination circle, and thus accelerates or retards the true passage of the star by a quantity varying as the secant of declination. The sign of this error would evidently be altered by reversing the declination circle upon its Ys, or, what is the same thing, by making the polar axis and the declination circle each perform half a revolution. The practical rule is, to observe the transit of a *star near the equator* over the middle wire of the telescope, noting both the *time* and the *reading of the hour circle*: Turn the polar axis and the declination circle each through 180°, and observe the star in the same way as before: Then, if the time elapsed between the two observations be equal to the difference of the two readings upon the hour circle, there is no error of collimation; but if these quantities be not equal, then half the difference between them, multiplied by the cosine of the star's declination, will give the error of collimation for a star in the equator.

The second of these errors (which is similar to that of inclination in the transit) causes the star to be observed in a great circle, which intersects the declination circle at the equator, and is most distant from it at the pole. The effect of this error upon the star's transit varies as the tangent of declination, and changes its sign with a half revolution of the polar axis. Hence, if the transit of a *star near the pole* be observed, exactly as in the foregoing case, (this observation must be corrected for the error of collimation previously determined), half the difference between the time elapsed during the two observations and the advance of the instrument upon the horary circle, will be the error due to the inclination of the declination circle.

M. Kreil then shews how the remaining errors of the instrument may be determined. The error of the declination verniers is readily found by observing a star (not too near the pole) in *declination*, before and after reversing the instrument as above directed; half the difference between the first and second readings being the error of the verniers. In all these cases, the star should be near the meridian, to avoid the effect of refraction.*

M. Kreil then gives examples drawn from actual observations made with a new equatorial added last year to the Vienna observa-

* The error of the polar axis in altitude may easily be discovered by meridian observations in declination of a star near the pole above and below the pole, allowing for the difference of refraction; the error in azimuth, by observing a polar star at 6^h and 18^h from the meridian. *The declination circle must not be reversed for these observations.*

tory. The circles are 2·1 feet in diameter, and the telescope has a focal length of 2·6 feet, with an aperture of 2·4 inches.

IV. On Barlow's new telescopes. By Professor Littrow.

It has long been a desideratum in practical optics to discover a means of shortening the focal length of refracting telescopes without reducing their aperture or injuring their distinctness. This can only be hoped for, in general, if we can increase the refractive or diminish the dispersive power of the crown-glass lens, or, on the other hand, diminish the refractive or increase the dispersive power of the flint-glass lens, which form the achromatic object-glass. The fluid lens of Mr. Barlow fulfils one of these conditions, for, with a refractive power not greater than that of the best flint-glass, it appears to have a dispersive power more than double, and thus enables us to diminish the focal length very considerably.

Professor Littrow gives the formula for a direct approximate solution of the curvatures to be given to the lenses when they are considerably separated from each other. The method is similar to that employed by Euler in his *Optics*, and requires, for the kind of lenses proposed by Mr. Barlow, an extension of the tables to be found in that celebrated work (these are given by Professor Littrow). This direct approximate solution is followed by an indirect accurate solution, similar to that already published by the author in the *Mem. Ast. Soc.*, vol. iii. p. 248, modified by the condition of the separation of the lenses, which enables us to reduce very much the size of the second lens.

Professor Littrow gives several examples of telescopes with large apertures and small focal lengths, and shews in each case that the *spherical* aberration is destroyed, as well as the *chromatic*.

V. A letter by Mr. Hubert to the President, suggesting the possibility that the discrepancies observed in pendulum experiments may arise from the effect of magnetic attraction. He recommends the pendulum to be swung, at the same place, in the magnetic meridian, and at right angles to it, in order to ascertain the fact; and that observers should be careful to swing the pendulum in the magnetic meridian for comparative observations.

VI. On Mayer's celebrated Catalogue of Zodiacal Stars, by Francis Baily, Esq.

Since the publication of the *Astronomical Observations* of Mayer, by the late Board of Longitude, Mr. Baily has examined the position of every star, by comparing each of them not only with the observations, but also with the catalogues of Bradley and Piazzi, by which means he has been enabled to detect many inaccuracies in Mayer's catalogue, which have hitherto puzzled the practical astronomer; and he has now given us a corrected catalogue, together with references to every observation of every star, in a collateral column, as well as the difference between the results of Mayer's observations and those of Bradley, his contemporary, in

another collateral column. The corrections which Mr. Baily has actually introduced are those only which are sanctioned by the observations themselves: at the same time, he has pointed out other corrections, which, although only conjectural, are highly probable; but these are kept distinct from the former. The author has subjoined a list of some other stars observed by Mayer, but not contained in his catalogue, as well as a list of several occultations. From the result of Mr. Baily's investigations, it appears that there is a very near accordance between Bradley and Mayer in the *declination* of the stars; and it is a remarkable fact, that the differences are almost always on the same side: the mean of all the comparison is 4″,27, which is the quantity by which Bradley's north polar distances exceed those of Mayer. There is a greater discordancy, as might be expected, in the *right ascensions*.

VII. A paper from Dr. Robinson, of Armagh, containing the results of his observations of Venus, for the purpose of determining thereby the mass of the Moon, in the way proposed by Professor Airy.

VIII. Two Memoirs by Don José Joachim de Ferrer, containing Observations made at the Havannah, from 1808 to 1812, with the resulting longitude and latitude of that city.

After a description of his instruments (which consisted of a 4½-feet telescope and a reflecting circle, both by Troughton, and an excellent chronometer by Arnold,) M. de Ferrer proceeds to state the manner in which his observations were conducted.

For latitude, he employed circum-meridian observations of the sun at the solstices, of Capella, and of Rigel, taking an equal number with the instrument direct and inverted, and reversing the roof of the artificial horizon after every observation. In no case does a set of observations appear to differ more than 4″ or 5″ from the mean of the whole. The latitude of the observatory of the Havannah is 23° 8′ 17″,5 N., and that of the great tower of the Moro 23° 9′ 26″,2.

For longitude, the author employed the occultations of fixed stars and planets behind the moon. He did not conceive that, in any case, there could be an error of more than 1ˢ, either in the state of his chronometer, or in the observation itself. The places at which the star entered and quitted the moon's limb were previously computed. The magnifying power used was 180.

As very few corresponding observations could be obtained, M. de Ferrer formed a catalogue of the occulted stars in longitude and latitude for 1756, from the observations of Bradley, Lacaille, and Mayer, and another for the beginning of the century, from those of Maskelyne, Piazzi, De Zach, and Lalande; and, from a comparison of these, determined the annual variation of each star, and its place at the time of observation. The longitude and latitude of the moon was computed by him *directly* from Burkhardt's Tables, and the error of the Tables determined by a comparison with meridian observations, or with occultations of known stars, at Greenwich, Paris, Gotha, &c. The mean of 20 results gives the longitude of

the Havannah west of Paris $5^h\ 38^m\ 47^s,7$, no observation differing 10^s from the mean. The great tower of the Moro is $1^s,6$ west of the observatory.

There are, besides some eclipses of the sun and moon, and of Jupiter's satellites, the bearings and situations of points in the Havannah and in the island of Cuba.

" It will be seen, that, by these observations, I have deduced two values of the *Moon's inflexion;* the first by the time observed between the bisection of the star's disc and the instantaneous disappearance, and the second by the *duration* of the occultation, compared with the *calculated* semidiameter: I find the mean semidiameter to be used for reducing altitudes or meridian observations $= 15'\ 34'',27$; for eclipses and occultations, $15'\ 32'',34$.

The two values of the moon's semidiameter may thus be obtained, independently of micrometrical observations. Although the greater part of astronomers have noticed the extraordinary phenomenon of seeing the star between the observer and the moon, no one that I know of has thought of deducing from it the true inflexion. The semidiameter, as determined by micrometer, will be about $3'',8$ greater than that deduced from occultations."

All the necessary details, both of the instruments, observations, and calculations, are given with great distinctness, and leave nothing to be desired either for accuracy or clearness.

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

November 12, 1830. No. 30.

THE following communications were read:—

I. Ephemeris of the occultations of α Tauri in 1831, for ten European Observatories, by Mr. Maclear.

This list of occultations has been computed to within 5^s, and then verified by another process.

In addition to the sidereal and mean solar time of the immersion and emersion of the star, the author has determined the place on the moon's limb where the phenomenon takes place, by reference to the *vertical* point, and also to the *northern* point of her disc. The latter mode he conceives is most convenient, where the telescope is mounted equatorially.

The present list is peculiarly favourable for general observation, as in several cases the occultation happens when the moon is near her transit.

II. Practical rules for the approximate prediction of occultations, by Mr. Henderson.

Instead of computing the parallax of the moon by the trigonometrical tables, Mr. H. obtains them with sufficient accuracy from the traverse table contained in the *Nautical Tables of Mendoza Rios, second edition*, 1809; and the proportions, in which 60^m is always one of the terms, are worked by means of *Taylor's Sexagesimal Table*. The results may generally be taken out by inspection, and in every case the interpolation is very easy.

The practical rules are made to apply to three cases, 1st, when the elements are given as in *Encke's Ephemeris;* 2dly, with the *Nautical Almanac* elements; and, 3dly, when the computer has only a catalogue and an ephemeris of the moon. An example of the computation is given in the first two cases, and Mr. H. states that the time employed upon each was about fourteen minutes.

III. A note by Mr. Gompertz, to a paper by M. Kreil on the rectification of the equatorial.

As M. Kriel's paper contains only the formulæ for the problem, without any demonstration, Mr. Gompertz has investigated them, and shewn their accuracy. He has also noticed some other possible causes of error, as, if the horary circle be not fixed at right angles to the polar axis,—if there be any eccentricity in the divided circles, &c.; and shewn the *nature* and *order* of the corrections which would be thereby required.

IV. Occultations observed at Boston, Massachusetts, by Mr. Robert Treat Paine.

Mr. Paine gives the mean solar time of six complete observations of Aldebaran (immersion and emersion), five at Boston and one at Nantucky, with a $3\frac{1}{2}$ feet achromatic telescope, and a magnifying power of 60: the telescope was adjusted on a star. "In four of the observations nothing remarkable was noticed, except that when the immersion or emersion took place on the enlightened limb, the star became so tremulous as to cause an uncertainty of 1^s or 2^s; but in two other instances (one at emersion and the other at immersion) the star did actually appear projected upon the face of the moon for about 2^s; and the light of the star was in both instances very much more brilliant than usual, although the emersion took place about sunset, and the immersion while the sun was above the horizon."

"On September 17, 1829, about 10^s before immersion, the star spread out, and appeared like a star viewed through a telescope not adjusted to distinct vision, and then faded away so gradually that its final disappearance could not be noted with greater precision than 3^s or 4^s. The same appearance was seen by another gentleman observing at a place $2\frac{1}{2}$ miles distant from me."

V. Observations upon the period of the variable star β Lyræ, by Mr. W. R. Birt.

In the year 1784, Mr. Goodricke remarked that β Lyræ varied from the third to the fifth magnitude, and fixed the period of this variation at $6^d\ 9^h$. On the 22d May, 1830, Mr. Birt commenced a series of observations upon this star, and at 11 hours found it of the fifth magnitude, and equal to ε and ζ Lyræ. Supposing the period to be that assigned by Mr. Goodricke, eight revolutions would have been performed in fifty-one days exactly; but when viewed by Mr. Birt on the 12th of July, at 10 o'clock, it was about 3·4 magnitude, and less than γ Lyræ; while on the 13th it was decidedly of the fourth magnitude, and on the 14th of the third, or as bright as γ. Mr. Birt, therefore, concluded, that it came to its minimum brightness between the 12th and 13th, and that the period was therefore longer than that assigned to it by Mr. Goodricke. This conclusion was confirmed by an observation on the 2d of September, when at 11 o'clock the star was exactly equal to ε and ζ, as on the 22d of May, thus giving 103 days for sixteen revolutions, or a period of $6^d\ 10^h\ 40^m$, instead of 102 days, which would have been required if the period were $6^d\ 9^h$. It would seem that the duration of its maximum, as well as of its minimum brightness, is somewhat irregular. Mr. B. gives several comparisons of the star with γ, ε, and ζ Lyræ, from May 22 to September 15.

VI. A paper on terrestrial refraction, by the late Mr. Henry Atkinson.

On the fluctuations of the atmosphere near the earth's surface; and

On the effect of such fluctuations upon the refraction at the horizon, and at very low altitudes, especially on the dip of the horizon at sea.

(*Unfortunately, these papers are unfinished: the ingenious author did not live to complete them.*)

In these investigations Mr. A. proposed to himself to demonstrate,

1st, That the fluctuations in the state of the atmosphere near the surface of the earth are not only fully adequate to account for the very great variations which have been observed in the horizontal refraction, but even for still greater variations.

2dly, That the variations of the dip of the horizon at sea are caused by the fluctuations of the atmosphere, and can be calculated when the latter are known.

The extreme uncertainty of the law of the variation of temperature near the earth's surface has been remarked by every observer who has directed his inquiries to this subject, by a proper adaptation of course and distance to the circumstances of the problem.

We find well-recorded cases where small alterations of elevation have produced very sensible effects upon the air, sometimes increasing and sometimes diminishing its temperature; and, again, at other times, we find the temperature of the air nearly the same through very considerable altitudes. (See *Wells*, *Humboldt*, &c.)

In order to subject to calculation the different hypotheses which may be imagined, Mr. A. supposes that the variations of temperature may be actually observed within certain limits of altitude (he has here assumed fifty feet); and that the state of the atmosphere at great elevations, for example at 1125 feet above the surface of the earth, may be considered to be in a *mean state*. Considering the state of these upper and lower portions of the atmosphere to remain unchanged, he calculates the change in the whole horizontal refraction which would be produced by two arbitrary and very dissimilar suppositions as to the distribution of temperature in the intermediate portion of 1075 feet, and draws the conclusion, that the variation of refraction arising from any conceivable derangement in this middle portion will be inconsiderable, compared with that which may be produced by changes in the lowest portion.

In considering the problem of the dip of the horizon, Mr. A. first obtains an expression for it where there is no terrestrial refraction, and deduces this simple approximate formula, that the dip in seconds $= 63'',82 \times \sqrt{h}$, where h is the altitude in *feet* above the level of the sea.

But when account is to be taken of the terrestrial refraction, Mr. A. finds, that if the included arc of the earth's surface be to the terrestrial refraction as $n : 1$ (and this is to be determined from a table of terrestrial refraction according to the then existing state of the atmosphere), the preceding expression is thus modified. The

dip in seconds $= 63'',82 \times \sqrt{\frac{n-2}{n}} \times \sqrt{h}.$

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ASTRONOMICAL SOCIETY OF LONDON.

December 10, 1830. No. 31.

THE following communications were read:—

I. On a Method of determining the Declinations of Stars with one Mural Circle, by J. Pond, Esq. A.R.

It will be recollected by astronomers, that the method employed at Greenwich for observing declinations (before a second circle was erected) consisted in determining the *mean index error* of the mural circle for considerable portions of time, and then in correcting all the observations during each portion by the index error thus found. From the great stability of the Greenwich circle, this method was the most advantageous and simple in practice; but many persons have been erroneously led to conceive that it was *essential* to that class of instruments, and that when absolute altitudes, &c. were wanted, the instrument was required to remain unchanged for many hours, or even days.

The method suggested by the Astronomer Royal is, to determine the sum and difference of two neighbouring stars, as, for instance, of *Castor* and of *Pollux*. Let the two stars be observed by direct vision on the same night, and call their difference in altitude (corrected for refraction, aberration, &c.) d. On any following night, let one star be observed by direct vision, and the other by reflexion. The difference of these readings (corrected as before) will give the sum of their altitudes, or s. The absolute altitude of each star will be respectively $\frac{s+d}{2}$, $\frac{s-d}{2}$, from which, with a knowledge of the latitude, the N.P.D. of each is immediately found.

It is almost unnecessary to remark, that, in repeating the experiment, the process may be varied by obtaining the difference of the altitudes by reflected observations, and the sum by reversing the stars. It will be noticed, that none of the divisions which enter into the first determination can possibly occur in the second; so that the determination is as practically perfect as can be attained by this instrument: moreover, it requires neither the investigation of index error, nor of horizontal points.

II. A Letter from Capt. P. King, R.N. on a Comet seen near the South Pole.

"This comet was discovered by Lieut. Wickham, of H.M.S. *Adventure*, on the night of the 18th of last March. An imaginary line from γ *Crucis* through α *Crucis* to the smaller nebula, being

crossed by another from *Sirius* through the larger nebula, their intersection would be very close to the comet's position. It was very bright and large. At midnight the following angular distances were measured with a sextant.

Comet and α *Crucis*	31°	50′	30″
——— *Sirius*	71	0	0 ”

Three weeks after, when Captain King had arrived at the Strait of Magalhanes, the comet was too faint to be observed: it was seen near θ, ν, δ *Jononis Pavo*.

A notice of the same comet, from Sir Alexander Johnstone, was communicated by Mr. Baily. It was discovered by Prof. Dabadie, at the Mauritius, on the evening of the 16th of March. It was first seen between the *Chameleon* and the great nebula. The next day it had advanced about 5° towards the north, and it continued in this direction with a diminished velocity, till it reached the eastern wing of *Cygnus*, where it disappeared about the end of May. The length of its tail never exceeded 5°. Professor Dabadie had no observatory; but he made a great number of observations of its distance from several stars, and from three of these he deduced the following elements.

Longitude of ascending node	=	228° 31′
Inclination of the orbit	=	49 46
Place of the perihelion	=	238 13
Perihelion distance	=	0·897

Passage of the perihelion, April 11, at 21^h
Motion direct.

The distances from which these elements are deduced are as follow: —

	True time at Port Louis.					
1830.						
March 19 at	8^h	45^m	50^s	Comet and Canopus	= 36°	11′
	9	2	0	Comet and α Centauri	= 34	50
April 1 at	16^h	48^m	0^s	Comet and α Centauri	= 69°	34′
	17	21	0	Comet and α Aquilæ	= 43	50
April 15 at	16^h	25^m	50^s	Comet and α Aquilæ	= 21°	50′
		40	50	Comet and α Centauri	= 97	39½

III. A letter from Sir Thomas Brisbane, with occultations of fixed stars by the moon, observed at Makerstown, lat. 55° 34′ 45″ N. long. $0^h\ 10^m\ 4^s$ W.

There are nineteen occultations observed, chiefly by Mr. Dunlop, during 1829 and 1830, for which corresponding observations are desired. “ The north mark of the observatory is within sight of five of the points intersected by the trigonometrical survey, and the latitude and longitude above stated were determined by Colonel Colby, from angles which I had observed with one of Troughton's 18-inch azimuth circles, with a telescope of 30 inches.”

IV. An Account of a Private Observatory, recently erected at Bedford, by Capt. W. H. Smyth, R.N.

After a mature consideration of the objects he had in view, Capt. Smyth decided upon the following plan of an observatory:— A meridian instrument room, 17 feet long, 12 broad, and 10 high; and on the west of this, a circular room, 15 feet in diameter, for an equatorially-mounted telescope. The situation is favourable, upon a hard bed of gravel, at a convenient distance from roads, &c., and commanding the passage of Fomalhaut to the south, and Capella S.P. to the north, clear of all obstructions.

The meridian room contains—

1. A dead-beat clock, with a mercurial pendulum. The wheel-work has been constructed with singular care: the steel rod *plunges* into the mercury, thus insuring a uniformity of temperature between the cistern and the rod, and is further secured from partial variations by a covering of brass tube. A "noddy" is placed upon the clock, to verify the steadiness of its supports.

2. A transit telescope, of 3½ feet focal length and 3·25 inches aperture, supported upon piers of Portland stone, 5 feet 7 inches above the floor, which, with their bases, each weigh a ton. The Y's are faced with Brazilian pebble, and rest, by a hemispherical base, upon corresponding sockets; so that the bearing is true along the whole of the pivot. There are five wires in the principal focus, and a sliding eye-piece. Two divided circles, of 6 inches diameter, are attached to the eye end, for *setting* the telescope. This instrument, with the accompanying level, are said by Capt. Smyth to stand the utmost scrutiny. In the meridian, at about 50 feet distance, is placed a deep-sunk pier, upon which a piece is fixed, carrying, as a mark, a small silver circle with a black dot in the centre. Distinct vision is obtained by interposing a 4-inch lens, of 49½ feet radius, fixed into the wall of the transit room. From the convenience and utility of this mark for collimating and adjusting, Capt. Smyth strongly recommends its adoption as a companion or substitute for a distant meridian mark.

3. The beautiful circle of 2 feet diameter, telescope 30 inches, made by Mr. Troughton, and presented to the Society by Dr. Lee. The divisions are by dots, on gold, to every five minutes, subdivided by two horizontal microscopes to seconds. This is accompanied by levels, plumb-line, and ghost apparatus. The whole stands on a massive stone, of nearly two tons weight, bedded on masonry descending to the firm substratum of gravel. To add to its power, a horizontal floating collimator is placed in the south wall, and immediately above the circle two horizontal beams, stretching across the observatory, support a large *vertical* collimator, which slides upon friction-rollers on an iron railway, when required to be removed from the zenith. These were constructed by Mr. Robinson, under Capt. Kater's personal inspection. A barometer, thermometers, &c. complete the furniture of this room.

The circular room is covered by a conical roof, furnished with the requisite openings, and resting upon three iron balls. This

room contains the equatorially-mounted telescope. The polar axis is formed of four thick slabs of mahogany, strongly braced together, and terminating in large bell metal pivots. The telescope, and the declination circle of 3 feet diameter, are carried by a stout axis passing through the centre of the polar axis, and are counterpoised by a ball of lead. The hour circle is of the same dimensions as the declination circle; it reads both time and space, and is fitted with a very efficient clamp and endless screw, to which a clock-work motion may be applied. The whole of the movements are remarkably easy; so that the telescope may be moved in any direction by the finger; nor is there as yet any flexure to be detected in the axis, or expansion in the supports. This is by Mr. Dollond.

The object-glass of the telescope is of 8½ feet focal length, with a clear aperture of $5\frac{9}{10}$ inches, worked by the late Mr. Tulley, from a disc purchased by Sir James South at Paris. It is considered by Capt. Smyth to be the finest specimen of that eminent optician's skill, and will bear with distinctness a magnifying power of 1200. To this are applied a double-line position micrometer, a rock-crystal micrometer, &c.

"In giving this high character of my telescope, it is proper to state, that I have tried its light by the cluster in the sword-handle of Perseus, by several of Messier's nebulæ, and by resolving portions of the Via Lactea into stars. Its distinctness is proved by the ready vision of the companions of Polaris, Rigel, α Lyræ, and α Capricorni, and also by the facility with which λ Ophiuchi, σ Aquarii, θ Persei, μ Cephei, δ Serpentis, ζ Herculis, and ϵ Bootis, are seen double; ζ Orionis and ξ Libræ triple; β Capricorni quadruple, and σ Orionis multiple. Lastly, I estimate its general action by the lunar montains, cavities, and shadows, under all powers; the lucid polar regions of Mars, the sharpness of the double ring of Saturn, the gibbous aspect of Venus, the shadows of Jupiter's satellites across his body, the splendid contrast of colours in α Herculis, γ Andromedæ, and other superb double stars; and the comparative facility with which such tests as σ Coronæ Borealis, τ Aquarii, θ Virginis, η Bootis, and δ Equulei, admit of measurement. It may not be uninteresting to add, that, in consequence of a letter from Mr. Herschel, I examined the remarkable orbital change of quadrant which has occurred in σ Coronæ since 1825, and that I have had a fair comparison with him in measuring the position and distance of δ Equulei to very considerable accuracy."

All the piers on which the instruments are placed are carried down to the solid gravel, and are clear of the floor, &c. The ground outside the observatory has been cleared away for the space of 10 feet, and the vacancy filled up with brick and gravel.

For meteorological observations, which have been in this country hitherto much neglected, the Bedford Observatory is provided with a rain-gage, evaporator, hygrometer, and weather-cock.

The objects to which Capt. Smyth first applied himself were the *determination* of the latitude and longitude of his observatory.

For the latitude, two independent methods were adopted; that of observing the zenith distances of known stars, the zenith point being determined by the *collimator;* and that of the zenith distances of Polaris above and below the pole, in reversed positions of the instrument, using the plumb-line and level apparatus.

Of the collimator, Capt. Smyth remarks—" Having experienced much loss of time, when on public service, from the necessity of awaiting consecutive periods for completing observations, I resolved to give Capt. Kater's vertical collimator a strict trial as a zenith point. In using it with the Beaufoy circle, I was much pleased with its action; for the convenience of each altitude being complete in itself without reversion, constitutes an invaluable quality. In the fifteen months which elapsed between taking down one circle and working the other, the collimator was covered up, on account of the dust occasioned by the workmen. Yet, soiled as it necessarily became, when it was occasionally uncovered for examination by astronomical friends, it constantly found as rigid a zero as before the interruption. In the annexed observations it will be seen, that the inclination of the floating optical axis was purposely varied by weights, without at all affecting the final deductions. The instability of levels, and the difficulty of pronouncing a plumb-line either perfectly straight or cylindrical, are universally acknowledged. The principal claim of the collimator to regard is, that, by its azimuthal motion of 180°, it shews the amount of the error of collimation in altitude, and of any deviation in the circle's vertical axis, and thus gives the means of yielding a complete and final result for every single observation.

" On the whole, from witnessing that it possesses sufficient stability for its time of action, I have arrived at the conclusion, that this powerful appendage, whether used above or below, will, in the end, be deemed an integral part of every meridian circle; that its cheapness, portability, and facility of correction, render it highly desirable and available to officers and others employed on scientific missions; and that its results harmonise in a more remarkable degree than by the usual means of level, or plumb-line, taken with twice the time and trouble. And when all the obstacles to the extensive use of reflection are considered, the collimator presents advantages too obvious to be overlooked."

Capt. Smyth then gives sixty observations of standard stars, for each of which the zenith point was determined by the collimator, and deduces from the mean of the whole.

The latitude of the Bedford observatory	52° 8′ 25″,45
By eight observations of Polaris, above and below pole, face east and face west, instrument adjusted by the plumb-line and levels.....	52 8 29 ,71
Mean.....	52 8 27 ,58 N

From six observations of the moon and moon-culminating stars,

half of the first and half of the second limb; and compared with corresponding Greenwich observations,

The longitude of the Bedford observatory	=	1m	51s,975 West.
From four *corresponding* occultations ...		1	51 ,486
From thirty-eight *non-corresponding* occultations and eclipses of Jupiter's satellites		1	47 ,948

Capt. Smyth is inclined to adopt, for the present, 1m 51s,7.

The occultations were computed from a formula investigated by Mr. Maclear.

*** *This Number terminates the First Volume of the Monthly Notices.*

J. MOYES, TOOK'S COURT, CHANCERY LANE.

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J. MOYES, TOOK'S COURT, CHANCERY LANE.

MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY,

CONTAINING

ABSTRACTS OF PAPERS,

AND

REPORTS OF THE PROCEEDINGS

OF

THE SOCIETY,

FROM JANUARY 1831 *TO JUNE* 1833.

VOL. II.

LONDON:

PRIESTLEY AND WEALE,

HIGH STREET, BLOOMSBURY.

1833.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *January* 14, 1831. No. 1.

The following communications were read : —

I. On the Computation of observed Occultations, by Mr. Maclear.

When observed occultations are used either for determining the longitude of the place of observation or the errors of the lunar tables, it is desirable to compute the parallaxes correctly in the first instance, so that they may not be affected by any error in the assumed longitude of the place of observation. This is attained by finding what has been technically called " the point of occultation," or the parallaxes of the occulting point of the moon, which, whatever be the longitude of the place, depend solely upon the horizontal parallax at that moment, the geocentric latitude and sidereal time of the place, and the right ascension and declination of the star.

It is evident, that if we suppose the star to be elevated as much as that portion of the moon with which it is in contact is depressed by parallax, it would still appear in contact to a spectator at the centre of the earth,* and the operation of finding the longitude will proceed as if the observation were made at the centre.

Mr. Maclear has investigated accurate expressions for the parallaxes of the point of occultation, which are as follow:—

$$\text{sin parallax in } \text{Æ} = \frac{\text{sin hor}^{\text{l}}\text{. par.} \times \text{cos lat.} \times \text{sin hor}^{\text{y}}\text{. angle of star}}{\text{cos (declin. of star + par. in declin.)}}$$

$$\text{sin parallax in declin.} = \text{sin hor}^{\text{l}}\text{. par.} \times \text{sin lat.} \times \text{cos declin. of star}$$

$$- \frac{\text{sin hor}^{\text{l}}\text{. par.} \times \text{cos lat.} \times \text{sin star's declin.} \times \text{cos (star's hor}^{\text{y}}\text{. ang.} - \tfrac{1}{2}\text{ par. Æ)}}{\text{cos } \tfrac{1}{2}\text{ par. in Æ.}}$$

The inconvenience of thus reciprocally involving the quantities sought for in the expressions from which they are to be obtained, is inevitable, unless we increase the number of terms, or sacrifice accuracy. The parallax in declination may be computed very nearly, neglecting the parallax in right ascension; and with this

* There is a very slight difference, which is investigated by the author, and shewn rarely to exceed a fraction of a second of space.

value the parallax in right ascension may be obtained with sufficient accuracy. The second part of the parallax in declination may now be recomputed, if necessary.

Mr. Maclear then gives practical rules for computation, adapted to common and to proportional logarithms, with several examples, and subjoins tables for the reduction to geocentric latitude, and logarithms of the earth's radius for every three degrees of latitude, the compression being assumed $\frac{1}{300}$.

II. Observations of the Right Ascension of Venus, to determine the Mass of the Moon, (as recommended by Professor Airy), by Professor Nicolai, at Mannheim, and Professor Schwerd, at Spire.

19 right ascensions of the bright limb of Venus, observed on the meridian of Mannheim, from March 3 to April 30, reduced by the catalogue of the Berlin Ephemeris for 1830; with the mean solar time of transit at Mannheim.

20 apparent right ascensions and declinations of the bright limb of Venus, from January 9 to March 29, observed on the meridian of Spire.

Along with the observations of Venus, Professor Nicolai has sent his observations of Gambart's comet, viz.

28 apparent right ascensions and declinations of the comet, from May 18 to July 27, with the corresponding mean solar time, observed with a circular micrometer applied to a $4\frac{1}{2}$ feet telescope by Fraunhofer.

"From these observations, up to the 25th of June, along with the first Marseilles observation of April 21, I have deduced the following parabolic elements of the comet, which represent with great accuracy the July observations."

April 1830.

Time of the perihelion.	9·32533	M. T. at Mannheim, 24m 30s east of Paris.
Log. of least distance	9·9644660	
Long. of perihelion	212° 11′ 46″,9	From the mean equinox of April 9.
Long. of ascending node ...	206 21 43 ,9	
Inclination of orbit	21 16 29 ,1	

Motion direct.

"In the computation of these elements, I have had regard to aberration and parallax, as well as to precession and nutation."

III. Observations of the Right Ascension of Venus, about her inferior Conjunction, by Professor Santini, at the Imperial and Royal Observatory of Padua.

The instrument used for these observations is a transit telescope, by Reichenbach, of $3\frac{1}{2}$ feet focal length. The position of the instrument is ascertained by a very sensible level, and by a meridian mark. At night, when the mark is not visible, the azimuthal deviation is obtained from the transits of the fundamental stars, and corrections for the position of the instrument applied to the observed

transits. Professor Santini expresses a fear that the supports of the instrument are not so stable, or the clock so equable in its rate, as may be necessary for these very delicate observations.

47 observations of the right ascension of the enlightened limb of Venus, with the fundamental stars with which it is compared, and the resulting error of the small Ephemeris of Venus distributed by the Society.

Along with the observations of Venus, Professor Santini has transmitted positions of Gambart's comet, deduced from observations with the equatorial instrument of the Observatory of Padua, by himself and his colleague, Dr. Conti.

50 positions of the comet of Gambart, in right ascension and declination, with the corresponding mean time of Padua, from April 30 to June 13.

"From the observations of the 30th of April, and of the 8th and 18th of March, I have deduced the following parabolic elements, without regard to the small corrections due to aberration and parallax, and they continue to satisfy the observed places. Whence we may conclude, that the orbit will only require some minute corrections, and that it is nearly parabolic. In the catalogue of comets published by Professor Schumacher I do not find any one which resembles it."

	April 1830.	
Passage of the perihelion.....	9·63804	Mean time at Padua.
Log. of perihelion distance ...	9·9650486	
Longitude of perihelion	212° 23′ 18″,8	Reckoned from mean equinox.
——— node.....	206 22 43 ,1	
Inclination of the orbit.....	21 11 8 ,8	

Motion direct.

IV. A Letter from Professor Bianchi, of Modena, containing Observations of the Right Ascension of Venus.

These observations were made with the meridian circle by Reichenbach, and the time taken from an excellent clock with a mercurial pendulum, by Molyneux. Professor Bianchi gives the transits of the fundamental stars, and 63 transits of Venus, as observed between the 2d of January and the 9th of May.

As no sensible change of inclination could be detected in the instrument, the rate of the clock was determined by transits of α Cygni which are nearly independent of changes in azimuth. The position of the instrument in azimuth was also verified as often as possible by a very distant meridian mark; and as, in this respect also, no variation could be perceived, Professor Bianchi preferred calculating "the mixed equation of the clock and instrument" for stars nearly in the parallel of Venus, without ascertaining the actual error of the clock, or the deviation of the instrument from the meridian. The mixed equation is thus determined. The *apparent* places of certain fundamental stars being first computed, the

difference between these and the *observed* places may arise from two causes; the error of the clock, and the displacement of the instrument. The form of this error is $m + c \sec \delta + n \tan \delta$; and since m affects all stars alike, the effect of the variable part on Venus may be determined by comparing stars nearly in her parallel with fundamental stars differing in declination. In this way, values of the variable part of the error have been obtained for each month for the stars near her parallel, by comparing them with α Lyræ, α Cygni, α Andromedæ, Capella, and Sirius, which, when combined with the clock rate and clock error as shewn by these fundamental stars, gives the correction to be applied to the observed right ascension of Venus, in order to obtain the true right ascension.

In this manner the right ascension of the bright limb of Venus has been finally ascertained, and compared with the small Ephemeris.

Several measures of the diameter of Venus are added, which have been deduced from repeated observations with the double-image micrometer of Professor Amici, applied to a 30-inch telescope by Dollond, and confirmed by observing the upper and lower limbs of Venus with the meridian circle. Professor Bianchi has also added

25 positions in declination of the centre of Venus, between March 15 and May 8, corrected for refraction.

V. Occultations of the Stars and Planets observed at Dorpat, by Professor Struve.

Professor Struve observes, that "even with such a powerful telescope as the Dorpat refractor, it is not easy to observe the *emersion* of faint stars from the moon's bright limb. But the micrometer, with the clock-work horary motion, affords a very satisfactory method of measuring the distance of a star, after emersion from the enlightened disc. These observations replace a lost emersion, and have even this advantage over an emersion exactly observed—that they do not depend upon the inequalities of the edge of the moon. Such micrometrical measures, both at immersion and emersion, will be found in the accompanying occultations of the Hyades. An accurate computation will shew what degree of accuracy may be expected from this mode of observing, and if there be a constant error in the apparent diameter of the moon depending upon the telescope employed. These measurements are, however, very difficult, and, I should think, better adapted to Fraunhofer's heliometer than to the wire micrometer."

The telescopes were variously adjusted, upon close double stars, upon Aldebaran, and upon the moon; but though there were four or more observers, in no instance was any projection seen. The disappearances took place instantaneously, when the apparent centre of the star entered upon the edge of the moon, and the re-appearances were also instantaneous; neither was there any previous variation in the brilliance of the star.

The observations consist of

An occultation of Saturn by the moon	16 Feb.	1826	
An occultation of α Tauri	25 July	1829	Four observers.
———————	15 Oct.	——	———
Occultations of α Tauri and the Hyades	9 Dec.	——	Six observers.
Occultations of the Hyades	28 Mar.	1830	

VI. Two Notes by Mr. Lubbock, on the Comet of Halley.

In the first of these notes Mr. Lubbock has deduced the elements of the orbit of this comet from Messier's observations, adopting the value of the semiaxis major given by M. de Pontécoulant, and the perturbations due to the principal planets computed by M. Damoiseau. The elements thus obtained satisfy, with considerable exactness, Messier's observations from Jan. 22 to June 3, as is seen from an accompanying table; and as they differ sensibly from those stated by the author in his paper, vol. iv. p. 42, he wishes them to be substituted in that place.

Semiaxis major	18·0763	
Eccentricity	·9676	
Perihelion passage, 1759, March	13·333	Mean time from Paris midnight.
Inclination of orbit	17° 36′	
Longitude of the ascending node	53 45	} Referred to the mean equinox
Longitude of perihelion.....	303 3 20	} 1759.

Adding to the above elements the perturbations given by M. de Pontécoulant, the elements for 1835 are as follow:

Semiaxis major	17·98355	
Eccentricity	·967348	
Perihelion passage, 1835, Oct. 31	$4^h\ 47^m$	Mean time from Paris midnight.
Inclination	17° 42′ 50″	
Longitude of ascending node	55 3 59	
Longitude of perihelion.	304 23 39	

Mr. Lubbock then briefly explains the mode by which these elements were computed.

In the second note, Mr. Lubbock analyses a very valuable paper upon the same subject, by M. Rosenberger, contained in the *Astron. Nach.* Nos. 180 and 181.

M. Rosenberger first obtained approximate elements from 5 of Messier's observations, adopting the semiaxis major of Damoiseau. He then calculated the effect produced upon the elements by the perturbations of the seven large planets, for every ten days, from the 1st of January to the end of May, 1759. With the corrected elements belonging to each day, he computed an ephemeris of the comet, employing, for this purpose, the Solar Tables of Carlini, as corrected by Bessel, having regard both to precession and nutation. These computed places were carefully compared with the observed places. The positions of the stars with which the comet was compared were taken, when possible, from the *Fundamenta Astronomiæ*, or Piazzi's catalogue. When these were wanting, the *Histoire Céleste* and Bessel's *Zones* were resorted

to, and many stars were determined by Professor Bessel for this purpose. In reducing the observations, parallax and the differences of refraction were taken into account. Finally, all the observations which could be depended upon, those of Messier, Maraldi, Cassini, Bradley, Hell, and Darquier, were combined and made use of by the method of least squares. The elements resulting from this comparison are compared with Messier's observations, and the differences do not exceed half a minute in space. Mr. Lubbock finds the differences between his elements and those of M. Rosenberger more considerable than he had expected, especially the eccentricity: they are, however, of the order of the uncertainty which must exist in the calculation of the perturbations of the elements, between 1759 and 1835, and therefore practically of little importance.

It is to be regretted that M. Rosenberger has not used the semiaxis major of M. de Pontécoulant. He has, however, computed the variation of the elements produced by a small change in the semiaxis major, whence, adopting the value given by M. de Pontécoulant, the elements of the orbit are

Semiaxis major	18·0763	
Eccentricity	·96766333	
Perihelion passage, 1759, March	13·0763	Mean time from Paris midnight.
Longitude of ascending node	53° 47′ 47″,19	
Distance of perihelion from node	110 37 27 ,90	
Inclination of orbit	17 21 44	

Mr. Lubbock is, however, inclined to doubt whether this method is applicable, except when the change in the semiaxis major is very minute.

"This comet is one of those which most nearly approach the orbit of the earth. When in one of its nodes, it may be at a distance from us equal to $\frac{1}{20}$ of our distance from the sun; but the mass is so small, that a much nearer approach would give no just cause for alarm.

"It is to be hoped that ephemerides of this comet will be given for 1835, calculated upon at least three different hypotheses, with respect to its perihelion passage, in order that astronomers may know the lines in which to sweep for it each day, so that it may be detected as early as possible."

VII. A Letter from Mr. Herapath to the President, announcing the discovery of a comet.

"The first sight I had of the comet was on the 7th of January, on Hounslow Heath, about 6 A.M. The tail was then nearly perpendicular to the horizon, inclining towards the south, and of a white colour, apparently between 1° and 2° long. The head was of the same colour as the tail, but, in proportion, far more splendid. To me, it appeared to equal in light stars of the second magnitude, while it exceeded them in size."

Mr. Herapath took its distance with a sextant from two bright

stars, and found the distance of the comet from Arcturus 60° 50′, and from α Lyræ 52° 45′, (the latter observation a little uncertain), at about $6^h\ 30^m$ mean solar time.

From these observations, Mr. Herapath concludes, as an approximate place of the comet,

Jan. 7. $6^h\ 30^m$ A.M. Æ $17^h\ 36^m\ 44^s$ S. Dec. $12°\ 33'$

An observation made by Sir James South, about 48 hours afterwards, gives

Æ $17^h\ 27^m\ 57^s$ S. Dec. $12°\ 1'\ 12''$

LONDON :—J. MOYES, TOOK'S COURT, CHANCERY LANE.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *February* 11, 1831. No. 2.

Report of the Council to the Eleventh Annual General Meeting of the Society.

IN meeting the Members of this Society, at their Eleventh Anniversary, the first topic of congratulation which the Council have to offer, is the change of style and name. The intimate connexion which exists between the objects of our association, and the honour and safety of the British Navy, has not escaped the attention of his Majesty. The countenance shewn to us by the Duke of Clarence, as Lord High Admiral, has been continued and confirmed by William the Fourth: and we are now assembled as the *Royal Astronomical Society*, with the Sovereign as our *Patron*.

Another important alteration in the condition of our body is on the eve of taking place, and, but for some technical delays, would have been this day announced as completed; viz. the obtaining a charter, and thus commencing an existence more immediately recognised by the laws. The motives for this proceeding have been already submitted to you, and have received your approbation and liberal support. It was generally felt that the Astronomical Society, from the consideration with which it was treated by men of science at home and abroad, by other kindred bodies, and by the Government, owed this mark of deference to opinion and to custom; and, in order to secure the possession of the property which we had acquired, or might be expected to acquire, from the liberality of our members, and to insure the appropriation of that property to the specific uses for which it was destined, it was necessary that we should no longer remain an irresponsible and unauthorised company of individuals. It has, however, been the careful endeavour of the Council to avoid any extension of the powers committed to themselves or to their successors, and not to cripple, by unnecessary limitations and directions, the operations of the future. Their objects have been to secure the property, perpetuate the existence, and augment the consideration of the Society, but in all other respects to leave the constitution untouched; and, above all, to continue the full exercise of power in the only proper guardians,—the body of the members at large. When the charter shall have received the sign manual, an altered and amended code of bye-laws will be proposed for your consideration. A few modifications have been suggested by experience, but they are neither extensive nor

numerous; so that we may look forward with a reasonable expectation of harmony and usefulness, warranted by the experience of the past. One alteration, for discontinuing in future the election of *non-resident* members, will be proposed to you to-day;* and the charter itself will be read for your consideration and approval.

The Report of the Auditors as to the receipt, expenditure, and present state of the Society, is as follows; viz.

Receipts.	£.	s.	d.
Balance of last year.....	286	2	5
Arrears, Feb. 1830 :—			
Resident members	25	9	0
Non-resident members.....	16	16	0
Contributions for 1830-1 :—			
8 admission fees	16	16	0
67 resident members (64 at 2 guineas, 3 at 1).....	137	11	0
8 non-resident members ...	33	12	0
4 compositions	84	0	0
Sale of memoirs	57	0	0
Arrears of ditto, Messrs. Baldwin and Co.	62	8	0
Sundries per Mr. Haggard and Mr. Maclear	1	6	0
	£721	0	5

Expenditure.	£.	s.	d.
3 gold medals and engraving	30	17	6
Engraving plates.....	8	18	6
1 year's rent to Michaelmas	52	10	0
Fenner, 2 bills for printing plates	13	11	8
Harrison, for stamps and stationery	16	7	10
Ditto, for commission	17	3	0
Sundry disbursements for porterage, postage, freight of foreign books, &c. &c.	37	18	3
Balance in the hands of the Treasurer, Feb. 1831 ...	543	13	8
	£721	0	5

Assets of the Society.

	£.	s.	d.
Balance in the hands of the Treasurer	543	13	8
Arrears, Feb. 1831 :—			
4 contributions of four years' standing £33 12 0			
4 ———— of three ditto 25 4 0			
7 ———— of two ditto 29 8 0	140	14	0
16 ———— for the past year 35 14 0			
2 ———— non-resident 16 16 0			
New Members :—			
6 contributions at 3 guineas 18 18 0			
1 ———— at 4 ditto 4 4 0	48	6	0
3 ———— non-resident 25 4 0			
1 year's dividend on £800 consols, due January 1831.....	24	0	0
½ ———— on £857 13*s.* 8*d.* 4 per cents, July 1830	17	3	0
½ ———— on ditto, now 3½ ditto, January 1831	15	1	0
The said stock, valued at about	1500	0	0
Various astronomical instruments, books, prints, &c. &c.			
15 silver medals, unappropriated.			

Abstract of the present state of the Society, as regards its Members :—

	Members.		Associates.
February 1830	243	.....	34
Elected since	22	.....	7
	265		
Died 5	7		
Resigned 2			
Totals	258	.....	41

* *This* proposal was unanimously adopted by the Meeting.

Patron	1
Compounded	45
Annual contributors	101
Non-resident	110
Honorary	1
	258

Amongst the losses which the Society has sustained by death, it is with particular regret we notice the decease of Commander Thomas Boteler, R.N. and of Mr. Tulley, the optician.

Commander Boteler was actively employed in surveying the western coast of Africa in H.M.S. Hecla, when he fell a sacrifice to the noxious climate of that fatal country. Few young men have distinguished themselves more in the scientific branches of his profession; and none ever pursued the important duties on which he was engaged with more disinterested and uncalculating ardour.

The skill of Mr. Tulley, as a practical optician, is too well known by every person present to demand any lengthened notice here. By long and careful experience, he had acquired a knowledge and tact which has never perhaps been surpassed in the construction of achromatic telescopes. In later times, it is true that large object-glasses have been worked with more success upon the Continent than in England: but it must be acknowledged that this superiority has been entirely owing to the greater excellence of the material. It is grievously to be lamented that much of the labour of this invaluable artist was absolutely wasted, from the impossibility of procuring flint glass capable of forming an object-glass at all; lens after lens having been rejected by him before one could be found of requisite purity, even of moderate aperture: while the splendid refractors which he constructed from *foreign* discs, within these few years, shewed that the difficulties lay, not in the artist's want of skill, but in the intractable and variable nature of his materials. It is pleasing to add, that Mr. Tulley maintained through life a character of great simplicity and unsullied probity.

The most prominent subject of public interest, (and one that has engaged much of the attention of your Council during the past year,) was the proposing an amended form of the *Nautical Almanac*. The Lords Commissioners of the Admiralty, being desirous that the National Ephemeris should be remodelled, so as to meet the increasing wants and intelligence of the navy, and also the demands of astronomers, referred the consideration of the subject to the Council of the Astronomical Society. A Committee was formed, with the co-operation of the most distinguished navigators and astronomers of the empire, and an elaborate Report drawn up, recommending various alterations and additions. This has been approved of by the proper authorities; and the *Nautical Almanac* of 1834 will appear in strict conformity with the plan advised.

The most important *alteration* is the substitution of *mean* for apparent solar time in all the data of the Ephemeris. It was with considerable reluctance, and after viewing the subject in every light, that the Committee resolved upon this material departure from the

mode adopted by Maskelyne, and rendered familiar by the practice of more than half a century; but, as chronometers are to be found in perhaps every ship which relies upon astronomical means for her guidance, and as mean time must necessarily be obtained where chronometers are used, it was deemed safer to dismiss apparent solar time altogether as unnecessary, and as being a source of confusion. The advantages, as to simplicity, of exchanging a varying for a constant measure of duration, and of assimilating the computations of the navigator and of the astronomer, are too obvious to be dwelt upon; and, in the opinion of all the naval officers present, no serious or lasting inconvenience from the change is likely to be felt.

The chief *additions* to the nautical part of the Ephemeris are, the right ascension and declination of the moon for every hour, the right ascension and declination of the bright planets for each day, and their distances from the moon for every three hours: additions, of which it will not be too much to say, that they more than double the facilities at present possessed for determining with accuracy the longitude and latitude at sea or on land.

For Astronomy, besides that which she enjoys in common with Navigation, we shall have all the data and minuteness, with the accuracy, of the most improved tables; the minor planets, an increased list of standard stars with their apparent places, and numerous other subjects of interest, which will be best learned from the Appendix to the Report inserted in the preface to the *Nautical Almanac* of 1833. Indeed, we may confidently hope that the extended *Nautical Almanac and Astronomical Ephemeris* will form an era in the progress of our science. The Report to the Lords Commissioners of the Admiralty, which embodies the grounds for each alteration, will, by the permission of their Lordships, appear in the Memoirs.

It has further been thought advisable by the Government to alter the constitution of the Board of Visitors to the Royal Observatory. The Presidents of the Royal Society and of this Society were respectively empowered to nominate five persons, and to form with these, and with the Savilian Professor of Oxford and Plumian Professor of Cambridge, a Board of visitation for our national observatory. A warrant with the necessary powers has been issued; and deliberations have already been held upon points of considerable importance.

Upon another very interesting topic, this Society, in conjunction with the Royal Society, has been applied to by the Government for their counsel; viz. as to the utility of supporting two observatories in the southern hemisphere. On a former occasion the Council gave an opinion in the affirmative; and a second deliberation has only strengthened the sentiments previously expressed. The observatory at the Cape is of the highest class, furnished with the best instruments which art can produce, and directed by an astronomer whose zeal and fidelity correspond to his information and his talents; whilst the Paramatta Observatory, founded and fostered by the provident munificence of Sir Thomas Brisbane, is required to fix

the geographical points of a growing empire — to facilitate terrestrial and maritime surveys — to act as a useful aid as well as check upon the meridian observations of her southern sister — and, favoured by its remarkable position as well as by a sky of unusual purity, to embrace a numerous and valuable class of phenomena not visible elsewhere. Your Council feel assured that their representations, and those of the Royal Society, will not be made in vain.

It is with great regret that your Council announces the retirement of Dr. Pearson (one of the earliest, steadiest, and warmest supporters of the Society) from the office of Treasurer. They have also to regret that the exertions, which Lieut. Stratford, R.N., has hitherto most unsparingly bestowed upon your affairs, have been found to trespass so deeply upon his time, as to interfere with other avocations, and oblige him to resign the Secretaryship. Feeling the impossibility of replacing this loss, and aware of the laborious and irksome nature of the duties which have been, up to this time, attached to the office, the Council were of opinion that an Assistant should be appointed with a salary, and thus render the duties less onerous to Mr. Stratford's successor; and they have accordingly chosen an Assistant Secretary, at a salary of £100 a-year. The Council must here gratefully acknowledge the very handsome offer of Lieutenant P. Lecount, R.N. to undertake Mr. Stratford's duties, after that gentleman's resignation; but the arrangement already mentioned has made such a sacrifice on his part unnecessary.

Little more would appear to be required for the complete establishment and comfort of the Society than a local habitation, where the members might enjoy the advantages of mutual intercourse, of their valuable library, and of their instruments. That we should meet in a house of our own is so essential to the objects of our association, and so imperiously called for by the position in which we stand, that we reasonably look for a speedy realisation of this hope, either from the care of Government, or from the liberality of our own body.

To our stock of instruments, Dr. Lee has added a divided circle, for shewing the mean time corresponding to a given sidereal time, and *versâ vice*; and Mr. Wollaston, a wire micrometer belonging to the telescope presented by his illustrious uncle.

To the library many valuable contributions have been made, amongst which may be particularly noticed the first volume of a Translation of the *Mécanique Céleste*, with notes, by one of our associates, Mr. Bowditch of New York; and Tables (*Tabulæ Regiomontanæ*) for facilitating astronomical reductions by another associate, the indefatigable Bessel.

The *Mécanique Céleste*, the mighty storehouse from which the geometers of the present generation have drawn the chief materials of their laborious speculations, is so abstruse and concise as to have obtained but a very limited number of readers, even in those countries where analysis is most successfully cultivated. Mr. Bowditch's work is designed to smooth the difficulties, and fill up the chasms, impassable to ordinary capacities; and thus

to bring physical astronomy, the ultimate object of practical astronomy, within the grasp of a larger circle of cultivators. We esteem this wise and spirited application of Mr. Bowditch's talents; and we hail it as a favourable augury of the future promise of his active and intelligent country.

The *Tabulæ Regiomontanæ* is another of those landmarks, ascertaining and securing the progress of astronomy, for which we are indebted to the author of the *Fundamenta Astronomiæ*. Before we can safely compare the theory of gravitation with the observed motions of the heavenly bodies, it is necessary to eliminate, as far as is possible, the uncertainties which might vitiate the process; and, for this purpose, the uniform practice of all good practical astronomers has been to determine, by repeated observations, a few fixed fundamental points, and, by a comparison with these, settle the place of every other body. Thus, the thirty-six stars of the Greenwich catalogue has formed for many years the groundwork of most meridian observations. In the present work, Professor Bessel has given tables by which the apparent place of each of these standard stars, and of the two pole-stars, may be readily found for every day from 1750 to 1850; depending upon the observations of Bradley and those of Professor Bessel himself. When, by these aids, the solar, lunar, and planetary observations have been reduced, it will be seen how nearly the theory of gravitation, and the tables which are founded upon it, represent the system of nature. The volume also contains other very important and useful tables, with the necessary explanations: and it is an additional advantage, that an universal language (the Latin) is used as the vehicle of communication.

In the printed Report of last year it was mentioned that a standard scale had been ordered by the Society, and that Messrs. Troughton and Simms had undertaken to execute it. Little progress has as yet been made, partly from the previous engagements of the artists, and partly from the consideration and caution required for the construction of so important an instrument: for, no sooner had your Council expressed an intention of authorising a standard unit of length, than the most flattering applications were made by Professors Schumacher and Struve, for verified copies on behalf of their respective governments. The Council have reason to believe that the standard measure which they may propose and execute will be adopted by the accomplished officers who conduct the Indian and Irish surveys. Lieut. Drummond, R.E. has offered his services for examining and verifying the divisions of the original scale; and this delicate and troublesome task will be gladly placed in such experienced hands.

Observations of the Right Ascension of Venus, for the purpose of determining the Mass of the Moon, in the manner pointed out by Professor Airy, and recommended by the Council, have been received from Dr. Robinson, and from Professors Bianchi, Nicolai, Santini, and Schwerd. More communications of the same nature will probably arrive; and it is hoped that, from a combination of

many excellent observations, Mr. Airy will be able to determine, with great exactness, this very important, and as yet uncertain element. Many valuable observations of Occultations have been communicated, from time to time, by public and private observers, which will appear, in a synoptical form, in the fourth volume of the Transactions. The lists of predicted occultations, to which we are mainly indebted for this plentiful harvest, have been computed in part by Lieut. Stratford, but chiefly by Mr. Henderson, who has thus acquired fresh claims to the gratitude of practical astronomers.

From Capt. Smyth we have received a very valuable collection of occultations, and of eclipses of Jupiter's satellites; with an interesting description of the observatory recently built by him at Bedford, and a determination of the latitude of the observatory by the *Lee Circle*, the zenith point being derived from the *Vertical Floating Collimator*. It is to be wished that we may be favoured, by other observers, with similar information, as it is only by repeated trials that the simplest and most effectual mode of pursuing astronomical inquiry can be discovered. Mr. Maclear has also presented a similar list of occultations, as observed by the *Wollaston telescope*, accompanied by a full and satisfactory description of the means employed by him for ascertaining the time. It would seem that entire confidence may be placed upon the observations of this gentleman and of Capt. Smyth; and the relative longitudes of Greenwich, Biggleswade, and Bedford, deduced by Mr. Henderson from corresponding observations, are almost as accordant as could be desired. From Mr. Ward, to whom the *Beaufoy Circle and Clock* are intrusted, no communication has yet been received, which may naturally be attributed to the short time they have been in his possession; a period (when the time unavoidably occupied in erecting and adjusting astronomical instruments is considered) insufficient for the completing a series of observations of moment.

The *Beaufoy Transit and Clock* have been returned by Capt. Smyth, and are now at the disposal of the Council, to be lent, agreeably to the rules laid down by the Council for that purpose, to such members as may be desirous of making observations with them.

Three comets have been discovered in the course of the last year; the first by Mr. Gambart, at Marseilles, who gave immediate information of it throughout Europe. We have received observations of this comet from Professors Santini and Nicolai, who have severally deduced the elements of its orbit, and from the President. The second was seen and observed near the South Pole, by Professor Dabadie (who also computed its orbit), and by Capt. King. And the third was recently discovered by Mr. Herapath. The observations and orbit of the comet of Gambart will appear in the Transactions, vol. iv. part 2, which will speedily be published. Part 1 has been for some months before the public.

The Council has this year awarded two of its gold medals; one to Capt. H. Kater, for the invention of the *vertical floating col-*

limator; and the other to M. Damoiseau, for his Memoir upon the Theory of the Moon and for his Lunar Tables.

The inconvenience and, in some instances, the uncertainties to which the plumb-line is subject, and the instability of spirit levels, have long tormented and perplexed the practical astronomer, while observations by reflection, which have recently been much used, are, though unobjectionable where applicable, necessarily limited in practice to favourable situations. The vertical floating collimator enables us to ascertain the zenith point with more ease, and probably with greater accuracy, than either the level or plumb-line; and is expected scarcely to yield in exactness to observations by reflection; while it is undoubtedly of more universal and easy application. In one important respect (that of obtaining a complete result without altering the principal instrument) the collimator is invaluable.

The motion of the moon has engaged the attention of astronomers from the earliest ages; and has justly been considered, from the paramount utility of the object, as well as the difficulties of every kind which envelope the research, the most sublime branch of astronomy. M. Damoiseau, in his elaborate treatise, has carried his approximations beyond any former mathematician; and that with a detail and clearness which are the best guarantees of truth. The magnitude of the labour, the analytical skill of the geometer, the accuracy of the results, and the great perspicuity with which they are exhibited, have particularly fixed the attention of the Council; and have been the powerful motives for awarding the other gold medal to this distinguished mathematician.

Such is the Report of the proceedings of the past year, which the Council have the pleasure of presenting to the Society. For a more detailed notice of the memoirs communicated, they refer to the Abstracts, which are published every month, and distributed to such of the Members as may wish to possess them. The Council have the satisfaction of reflecting that, so far as in them lay, they have not been wanting to the honour and interest of the Society, or to the advancement and general diffusion of the science. By persevering in the same course, we must increase the power and usefulness of our union in every succeeding year; and we may reasonably hope that the progress of astronomy, geography, and navigation, may, for ages yet to come, be advanced and consolidated by the activity, harmony, and intelligence of the *Royal Astronomical Society.*

Titles of the Papers read before the Society, between February 1830 *and February* 1831.

March 12, 1830. On Mr. Pond's recent Catalogue of 720 Stars. By Francis Baily, Esq.

Extract of a Letter from Professor Harding to Dr. Tiarks, on the Occultation of Aldebaran, observed at Gottingen December 9, 1829.

On the Method of Computing the Longitude from an observed Occultation. By Edward Riddle, Esq.

April 7. Observations of the Planets made at the Imperial Observatory of Vienna, in 1828. By Prof. Littrow.

Observations of Occultations of Stars by the Moon, at Mr. South's Observatory, at Kensington.

Extract of a Letter from Charles Perkins, Esq. to the President, on the Observation of two Occultations, on the 28th March.

On the Method of ascertaining any Inaccuracy in the Pivots of Transit Instruments, &c. By Lieut. P. Lecount.

Fourth Series of Observations with a 20-feet Reflector, containing the mean places and other particulars of 1236 Double Stars. By J. F. W. Herschel, Esq.

May 17. On an appearance of Divisions in the exterior Ring of Saturn. By Capt. Kater.

Occultations observed at Biggleswade with the Society's Wollaston Telescope. By T. Maclear, Esq.

On the Comet discovered at Marseilles in the Constellation Equuleus. By the President.

Notice of the Performance of the 20-feet Achromatic. By the President.

June 11. Observations and Remarks made on a Passage from New South Wales to England. By C. Rumker, Esq.

A Letter from Lieut. Hartmann to J. F. W. Herschel, Esq. describing an Instrument constructed for him by M. Hohnbaum, of Hanover.

On the Rectification and Use of the Equatorial. By M. Kreil.

On Mr. Barlow's New Telescopes. By Professor Littrow.

A Letter by Mr. Hubert to the President, on the effect of Magnetic Attraction on Pendulum Experiments.

On Mayer's celebrated Catalogue of Zodiacal Stars. By Francis Baily, Esq.

A Paper from Dr. Robinson, of Armagh, containing the results of his Observation of Venus, for the purpose of determining thereby the Mass of the Moon, as proposed by Professor Airy.

Two Memoirs, by Don José Joachim de Ferrer, containing Observations made at the Havannah, from 1808 to 1812, with the resulting longitude and latitude of that city.

November 12. Ephemeris of the Occultations of α Tauri in 1831, for ten European Observatories. By Mr. Maclear.

Practical Rules for the approximate Prediction of Occultations. By Mr. Henderson.

A Note by Mr. Gompertz, to a paper by M. Kreil, on the Rectification of the Equatorial.

Occultations observed at Boston, Massachusetts. By Mr. Robert Treat Paine.

Observations upon the period of the variable Star β Lyræ. By Mr. W. R. Birt.

Two Papers on Terrestrial Refraction. By the late Mr. Henry Atkinson.

December 10. On the Method of determining the Declinations of Stars with one mural circle. By J. Pond, Esq. A.R.

A Letter from Capt. P. King, R.N. on a Comet seen near the South Pole.

A Letter from Sir Thomas Brisbane, with Occultations of Fixed Stars by the Moon, observed at Makerstown.

An Account of a Private Observatory recently erected at Bedford. By Capt. Smyth.

January 14, 1831. On the Computation of observed Occultations. By Mr. Maclear.

Observations of the Right Ascension of Venus, to determine the Mass of the Moon, (as recommended by Professor Airy). By Professor Nicolai.

Observations of the Right Ascension of Venus, about her inferior Conjunction. By Professor Santini.

A Letter from Professor Bianchi, of Modena, containing Observations of the Right Ascension of Venus, in order to determine the Mass of the Moon.

Occultations of the Stars and Planets observed at Dorpat. By Professor Struve.

Two Notes on the Comet of Halley. By Mr. Lubbock.

A Letter from Mr. Herapath to the President, announcing the discovery of a Comet.

List of Public Institutions, and of Persons, who have contributed to the Society's Library, Collection of Instruments, &c. since the last Anniversary.

Agricultural and Horticultural Society of India.
American Philosophical Society.
Cambridge Philosophical Society.
East India Company.
Geological Society of London.
Italian Society at Modena.
L'Académie des Sciences de Dijon.
London Institution.
Le Bureau des Longitudes.
Linnæan Society.
Literary and Historical Society of Quebec.
Royal Society.
Royal Institution.
Royal Asiatic Society.

Society of Arts.
Society for the Diffusion of Useful Knowledge.
University of Oxford.

Professor Airy.
John Avdale, Esq.
Charles Babbage, Esq.
Francis Baily, Esq.
Professor Bessel.
Professor Bowditch.
M. Cacciatore.
Professor Carlini.
M. Cerquero.
Dr. Civiale.
Rev. H. Coddington.
Professor De Morgan.
Editor of Bibliothèque Universelle.
Professor Encke.
M. Faraday, Esq.
M. Francœur.
Professor Gautier.
Robert Goodacre, Esq.
W. D. Haggard, Esq.
Professor Hamilton.
Professor Hassler.
J. F. W. Herschel, Esq.
Lieut. P. Lecount.
Dr. Lee.
A. A. Lindo, Esq.
Professor Littrow.
Sir Richard Phillips.
M. Plana.
Professor Quetelet.
Dr. Robinson.
Professor Sammering.
Professor Schumacher.
Professor Struve.
Richard Taylor, Esq.
Dr. Tiarks.
B. L. Vulliamy, Esq.
M. Weisse.
Alex. Wollaston, Esq.

*** *The titles and subjects of these presents are more fully described in the Memoirs.*

(*The President then addressed the Meeting on the subject of the award of the Medals, as follows:*—)

Gentlemen,—Practical Astronomy, although it had occupied the attention of philosophers from the earliest ages, made but little progress towards accuracy till the commencement of the seventeenth century. With an instrument, the invention of his own genius, and the work of his own hands, for Galileo was reserved the glory of discovering the satellites of Jupiter—the spots on the sun—the irregularities of the moon's surface—the phases of Venus—the singular appearance of Saturn—and the construction of the milky way.

He demonstrated that the planets moved round the sun—that the sun revolved on his axis—that the satellites of Jupiter were eclipsed by falling into his shadow—and that their immersion into, or emersion from it, might be employed for determining the longitude.

Notwithstanding the means which the telescope presented for determining with unexampled accuracy the positions of the heavenly bodies, more than half a century elapsed before it was generally applied to angular astronomical instruments; and it would be per-

haps difficult to select a more remarkable specimen of the baneful influence of prejudice, than that afforded by Hevelius, who, seventy years after the discovery of the telescope, exerted his great talents to support, by formal discussion with Hook, the superiority of plain over telescopic sights.

The improvement of the nonius by Vernier, and the invention of the pendulum clock by Huygens, formed the next era in practical astronomy: the former led to the construction of the quadrant as used by Flamsteed—the latter to that of the transit instrument, as employed first by Roemer; and subsequently by Halley* at the Royal Observatory.

The zenith sector of Hook, perfected by Graham,† conducted Bradley to the discovery of aberration and nutation; whilst the accuracy of large angular instruments by Bird, laid that foundation for modern astronomy upon which its present superstructure has been built.

But although British engineering had brought the mechanism of astronomical instruments to very considerable perfection, little had been done for the improvement of the telescope. Its unwieldy length compared with its aperture—the impracticability of using with it magnifying powers commensurate with the mechanical capabilities of the instruments, remained nearly as in the days of Galileo —till, in 1758, the discovery of the achromatic object-glass by Dollond gave a fresh impulse to astronomical inquiry; and the quadrant, which had long been the standard instrument for the determination of polar distances, became supplanted by the circle.‡ Astronomy gained much, and would have gained more by the change, had not the popular artist of that day§ forsaken the principles of his predecessors, and given to his circles azimuthal motion.

But amongst the founders of this Society we see the individual who, possessing the inventive genius of Graham, with the patient industry of Bird, has brought the fixed instruments of our observatories to such a degree of perfection, that little seems left for his successors to achieve. Having studied Troughton's mural circle, who can doubt its capability of leading us to truth, and that by the readiest means possible? Who that sees his transit instrument reversed again and again, yet retaining rigorously its meridian and horizontal positions—that sees it when distant many minutes of a degree from the meridian, fixed in it by a single sidereal observation, with nearly as much facility as an ordinary telescope is pointed to a star—who that sees it keeping its adjustments, not only for days and weeks, but even for months and years, can quit it without revering him who made it? Yet, notwithstanding the one retains its index error, and the other its meridian and horizontal adjustments, in a manner which to be believed must be witnessed,—

* Halley's transit instrument is still preserved at Greenwich.

† This instrument is also preserved at Greenwich.

‡ The Observatory at Oxford (as far as I know) is the only establishment where the quadrant is still in use.

§ *Ramsden.*

terrestrial points of reference, even to *them*, are highly useful. Thus, the bar of a distant window may be used for the one, or the luminous opening between two contiguous chimney-pots, seen in the horizon, may prove a wholesome verification to the other. Hence, in the establishment of an observatory, one of our first wishes is to command an uninterrupted view of the horizon in the direction of the meridian, for the erection of suitable objects, by observing which any alteration in the instrument's position can immediately be detected.

But as this necessarily involves control over a space of land which it falls to the lot of few to command; and as it frequently happens that, from atmospheric obstacles, the marks thus placed cannot be distinguished, any contrivance which can obviate these difficulties becomes desirable; hence it was that, about fifty years ago, the distant meridian mark of Rittenhouse's instrument having been rendered useless by interposed buildings, he happily availed himself of the fact, that rays issuing from the sidereal focus of the object-glass of one telescope fall parallel on the object-glass of another:* thus the cross wires of one telescope became a meridian mark to the other.

That means so simple, yet so adequate to perform the offices of distant marks, should have remained neglected till resumed by Captain Kater, is indeed surprising. Aware of the trouble in employing plumb-lines for the determination of the zenith point of circular instruments—having found, by experience, the perplexing instabilities of the spirit level—knowing that, in instruments moving in azimuth, constant reference to the one or the other is not only necessary, but indispensable,—he saw that the decussation of the wires in the sidereal focus of one telescope might be made to represent the horizon of another, all that was required being to float the former telescope on the surface of mercury. For the contrivance whereby this was effected, I must refer you to the *Philosophical Transactions*, as also for some observations made by the Bishop of Cloyne with it, when applied to the Dublin circle.

The process of reversion, however, being difficult in this construction of the instrument, the objection was obviated by placing its telescope perpendicular to the mercurial surface; and it is this form of the instrument for which your Council has decreed your gold medal. The description of it is given by Captain Kater in the *Philosophical Transactions* for 1828; as is also the *admirable* series of experiments under the sanction of which the instrument was offered to our notice.

Considered theoretically, its adaptation to the end for which it was designed admits of very little doubt; and it is to be regretted, that, from its discovery till the present time, no observations made by its use with large instruments have come to our knowledge—indeed, the only comparison instituted between it and the plumb-

* Vide Transactions of the American Philosophical Society, held at Philadelphia, for promoting useful knowledge, vol. ii. p. 181.

line (as far as I know) is that made by the Society's Lee circle, recently presented to us, in a memoir, by our foreign Secretary. His observations, however, are too scanty to justify any positive inference; nor does my experience with *small* instruments enable me to say whether, all circumstances considered, an accordance between the results closer than that found by Captain Smyth, namely, four seconds, was reasonably to be expected.

That the vertical collimator is more easily referred to than the plumb-line, there can be no doubt; and that in accuracy it must be at least equal to the spirit level, few, I think, will deny; it is to be hoped, therefore, that by its application to the twenty-five feet zenith micrometer, shortly to be erected at Greenwich by the illustrious Troughton, its right to supersede them altogether will at length be placed beyond dispute.

(*The President then, addressing Captain Kater, continued thus:*—)

Into your hands, Captain Kater, I have the honour to deliver this medal: you, sir, know full well, that opinions as to the relative capabilities of the plumb-line and the vertical floating collimator, to indicate the zenith points of our instruments, are not unanimous. But, sir, of the ingenuity which led you to the invention of the latter, and of its correctness in point of theory, there is but one opinion. You have rendered many services to science—may you contribute many more; and, with every one who hears me, most fervently do I hope, that you may live to see the vertical floating collimator regarded as necessary an appendage to every circular instrument, as is the telescope itself.

(*The President then resumed his address to the Members, as follows:*—)

The second medal of the Society has been voted by the Council to M. Damoiseau, for his Memoir upon the Theory of the Moon, and for his Lunar Tables.

Of all astronomical knowledge, that which concerns the moon is by far the most important. Visible, on an average, twenty-four days out of every month, her rapid motion relatively to the sun and fixed stars, long since pointed out her observed distances from the one or the other, as the most effectual means of discovering the longitude.

The instrumental means were soon furnished by British ingenuity; the quadrant of Hadley was manageable on ship-board, and the only obstacle to the determination of a ship's longitude at sea, by the observed distances of the moon from the sun or certain well-known stars, was presented by the errors of the lunar tables. To obviate this, rewards to a very considerable amount were offered for the amelioration of the tables by different governments; and on the discovery of the laws of gravitation by the illustrious Newton, it was fondly hoped that all difficulties would vanish. Halley, however, soon found that the places assigned to the moon by the

Newtonian tables but very imperfectly represented the observed places; and, impressed with the idea that the errors were periodical, he hoped, by observations of the moon, continued through one revolution of her nodes, to supply the necessary corrections for the future. In this, however, he was unfortunately mistaken; and the incongruity found between theory and observation was so considerable, as to induce in some minds a doubt even as to the accuracy of the Newtonian theory of attraction. Little was done, after the death of Newton, towards improving the theory of the moon, till the subject was taken up by Clairaut, Euler, and D'Alembert; but the tables of these profound geometers were but little, if at all, used.

In 1755, Mayer sent a copy of his tables, founded on the theory of Euler, to the British government; the co-efficients of his equations being deduced from his own and Bradley's observations. In these the errors of the tables, which, in the time of Newton, extended to six minutes, were now reduced to one; and Mayer's representatives received from the British government the parliamentary reward to which their deceased friend was so well entitled.

Subsequently these tables were improved by Mason from Maskelyne's observations; and, more recently, Bouvard, Burg, and Burckhardt, by availing themselves of the profound investigations of the illustrious La Place, gave to the lunar tables a perfection which, but a few years before, the most sanguine supporters of Newton had scarcely ventured to anticipate.

But in these tables theory and observation were combined. Feeling, however, that the lunar theory *now* needed not the adventitious aid of observations, M. Damoiseau undertook the formation of new tables. Carrying the approximations beyond what had been hitherto attempted — neglecting no equations, however trifling in their numerical value, he has placed before the public, tables far more extensive than any of his predecessors. They exhibit an extraordinary effort of human labour, and that of the highest order — they represent the lunar motions with greater precision than any tables previously constructed — they are to seamen an invaluable treasure, and entitle M. Damoiseau to be regarded as a benefactor to mankind.

(*The President then, addressing Captain Smyth, said:*—)

Captain Smyth,—Transmit this medal to M. Damoiseau; assure him of the high value with which we regard his Memoir and Lunar Tables; and express to him our regret, that, exclusive of our gratitude, the medal of the Royal Astronomical Society is the only return we can make for the services he has rendered to us and to our country.

The Meeting then proceeded to the election of the Council for the ensuing year, when the following Members were elected, viz.

President: John Brinkley, D.D. *Lord Bishop of Cloyne.*—
Vice-Presidents: Francis Baily, Esq. F.R.S. L.S. & G.S. and

M.R.I.A.; J. F. W. Herschel, Esq. M.A. F.R.S. L. & E. F.G.S. & M.R.I.A.; Rev. William Pearson, LL.D. & F.R.S.; Edward Troughton, Esq. F.R.S. L. & E.—*Treasurer:* John Lee, Esq. LL.D. —*Secretaries:* Augustus De Morgan, Esq. *Prof. Math. University of London;* John Wrottesley, Esq. M.A.—*Foreign Secretary:* Captain W. H. Smyth, R.N. F.R.S. & A.S.—*Council:* George Biddell Airy, Esq. M.A. *Plumian Prof. Ast. University of Cambridge;* Hon. Lord Ashley, M.P.; Charles Babbage, Esq. M.A. F.R.S. *Lucasian Prof. Math. University of Cambridge;* Peter Barlow, Esq. F.R.S.; Captain F. Beaufort, R.N. F.R.S.; Davies Gilbert, Esq. M.P. V.P.R.S. F.L.S. & G.S.; John William Lubbock, Esq. M.A. V.P. & *Treas.* R.S.; Edward Riddle, Esq.; Sir James South, F.R.S. L. & E. F.L.S. & M.R.I.A.; Lieutenant William S. Stratford, R.N.

LONDON:—J. MOYES, TOOK'S COURT, CHANCERY LANE.

ROYAL ASTRONOMICAL SOCIETY.

Vol. II. *March* 11, 1831. No. 3.

THE following communications were read:—

I. A Letter from Mr. Rumker to Sir James South, on the appearances of Stars on the Moon's Disc. The following is an extract:—

"The first is the appearance seen by Sir Thomas Brisbane and myself, 30th July, 1821. From the position of the moon's dark limb towards Regulus, I concluded that she would eclipse the star before setting, and apprised Sir Thomas Brisbane of it, who made the observation, whilst I attended to the time. Nothing particular appears to have been noticed by him at the immersion of the star behind the dark limb, which was particularly conspicuous at the time; but, after the emersion, he was astonished to see Regulus upon the moon's disc; and being invited by him to look at the star through the glass, I certainly observed the star, according to my estimation, upwards of 2′ inside of the moon's enlightened limb, where it remained sufficiently long for Sir Thomas and myself to exchange the telescope several times, and admire in turns the singular phenomenon.

"I must remark here, that on account of being afloat at the time, sailing along the coast of Cape Frio, which bore W.N.W.$\frac{1}{2}$W., distant about 5 miles, Sir Thomas Brisbane could only make use of a comet-sweeper for the observation, which may have been influenced thereby. Moreover, it was broad daylight, the sun having just set; but as Professor Wurm has deduced from the immersion and emersion respectively the following conjunctions,

	Mean time.			Conjunction.		
	h	m	s	h	m	s
Immersion	6	2	52,4	4	18	10,08
Emersion	6	12	59,7	4	18	5,74

(The star described a very small chord over the moon's disc.)

the observation cannot have been a bad one. Professor Wurm deduces thence the longitude of Cape Frio, 41° 46′ W. from Greenwich. Regulus was visible to the naked eye before the observation.

"In Bode's *Jahrbuch* for 1822, I find the following observation, made by Professor Burg, in Vienna, in a letter from the observer to Professor Bode, related as follows:—

"'1819, April 13. Emersion of α ♍ from the moon's dark limb at $12^h\ 3^m\ 22^s$ to 23^s apparent time.

"'At $23^h\ 3^m\ 17^s,1$ apparent time, I observed the emersion of a star 6·7 mag., which, about 5″ after, suddenly appeared to me like a star of the first magnitude; and it is from this transition that

I have dated the time of emersion. Perhaps Antares is a double star, and the first observed small one is so near the principal star, that both, viewed even through a good telescope, do not appear separated.'

"To this Bode remarks: 'Antares is no double star, and I explain the appearance observed by Professor Burg thus—that the star first appeared through the vapours of the moon's atmosphere at her dark limb, along which, however rare it may be, this atmosphere must have occupied a long track in the direction of the rays that entered the observer's eye from Antares, which, when clear thereof, suddenly appeared in its full splendour.'

"It is perhaps presumptuous to venture an explanation of a phenomenon so maturely examined by you. But you will not scrupulously criticise an hypothesis imparted by me to you. You know I forgot to take with me your interesting memoir when I left Camden Hill last; so that I cannot peruse it now. But I think the phenomenon has principally been observed upon the bright limb. Had now, in the above instance of Antares, that limb of the moon behind which the star emerged been enlightened, the moon's atmosphere would also have been enlightened, and have become visible to us, appearing a continuation of the moon's limb, but sufficiently transparent for us to have seen the star through it; so that, after observing its emersion, we still should have seen it within what we considered to be the moon's disc. Thus was it in the instance of Regulus, observed by Sir Thomas Brisbane and myself; and the long duration on that occasion was owing to the oblique direction in which the star traversed the annulus of the atmosphere.

"Astronomers have always deduced a smaller moon's diameter from eclipses of the sun than from meridian observations of the moon, and ascribe this to the inflexion, which is a confirmation of my hypothesis. We observe the contact of the moon's atmosphere with the wire, whilst we observe the encroachment of the moon's opaque body upon the sun.

"This phenomenon has principally been observed with the brighter stars, because the rays of the smaller ones could not pierce the atmosphere, and also do not always disappear suddenly at their immersions at the bright limb."

II. A paper on Irradiation, by Dr. Robinson, of Armagh.

That irradiation is variable, is shewn by examining a series of the sun's diameters in right ascension. Dr Robinson has observed, that when the observation is made through cloud or haze, a small diameter is given, the difference from the tabular diameter being the same for different apertures. By deducing from a large number of lunar transits the *probable* error of the observer, Dr. Robinson finds that, in his own case, this is only two-thirds of what really occurs, leaving unexplained an error of $0^s,155$ in the moon's right ascension, which he conceives may have arisen from changes of irradiation. Assuming the probable errors of the observers at Paris and Greenwich as less than his own, he finds a similar unexplained error of $0^s,195$.

By comparing the longitude of Armagh with that of several other observatories, as Kœnigsberg, Greenwich, Cambridge, and Paris, the observers are found to differ as to the moon, by a quantity varying from $0^s,39$ to $0^s,6$. Dr. Robinson then proceeds to shew the fact of changes in the quantity of irradiation, which may explain this, by the following experiments. A small circular hole, in a slip of brass, is placed in the focus of an object-glass, and viewed with a telescope through that object-glass. To make this hole, two slips are ground to fit closely, a hole is drilled through both, which is widened with a taper broach, and finished by grinding with a wire of the same size, and fine emery. Of these, that whose least section is at the surface of contact must be taken. The telescope used had a triple object-glass, of 47 inches focal length, and 2·75 aperture.

Dr. Robinson adds—"On looking through it when they were properly placed, the little hole, illuminated by a lamp behind it, appeared as a disc 17′ diameter, yellow, and something brighter than the sun in my transit observations of last month, but with a much more distinct and sharp limb than the sun presents, except in the most favourable state of the air. Then placing before the lamp a slip of oiled paper, its appearance became like that of the moon in a dense fog, perfectly well defined and visible, but without splendour, and looking like dead silver. In this state I made the micrometer wires internal tangents to the disc; and having the paper removed, I saw with pleasure two segments of the disc instantly project beyond the wires, and making the contact anew, had the measure of the enlargement of its diameter."

The excesses thus determined varied from 4″,8 to 5″,9, and with a disc of 11′ 20″, from 4″,85 to 5″,8. With a divided object-glass micrometer, the contact of the images was unaffected by their brightness or obscurity.

Here Dr. Robinson remarks—"If I have made no mistake, it shews that the whole of this irradiation was ocular, as there cannot be any sympathetic affection from one image of those adjacent parts of the retina which are already stimulated by the other. It also seems to shew that the projection of stars on the moon does not proceed from irradiation."

In applying a ten-foot Newtonian, it was found impossible to procure sufficient illumination; and a larger hole, viewed through the transit with a power of 156, gave excesses varying from 3″,72 to 4″,76. The illumination of the field of view had no effect on the disc in its brightest state, though it had on the obscure phase.

Dr. Robinson concludes, that irradiation originates chiefly in the eye, and that it is lessened by *strongly* illuminating the field of view. He recommends observing by reducing the aperture of the object-glass by a semitransparent diaphragm of oiled paper, which should fill the field with *scattered* light. By this means he has reduced the error in the sun's diameter from 0″,07 to 0″,008, and thinks it may be reduced still further by a diaphragm of emeried glass.

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *April* 8, 1831. No. 4.

THE following communications were read:—

I. Extract of a letter, dated March 24, 1831, from M. Cauchoix, of Paris, to the Rev. R. Sheepshanks:—

"I have just finished an object-glass larger than that of Sir J. South. Two satisfactory trials of it were made on the 17th and 22nd of March, by Messrs. Bouvard, Arago, Mathieu, and Gambard, on the trapezium of *Orion*, *Venus*, a difficult double star, and *Saturn*, with magnifying powers of from 200 to 1000; and though the sky was covered with light whitish clouds, the images were distinct and brilliant, without any colour or scattered light. I subjoin the exact measures of the object-glass, and the various magnifying powers employed up to the present time. M. Gambard, who has made more observations with this telescope than any other person, thinks that stronger eye-glasses may be easily adapted to it.

	Old French feet.			Metres.	English feet.	
	f.	*i.*	*l.*		*f.*	*i.*
Diameter of the convex lens.....	1	1	1·0	0·354	1	1·86
———— concave flint-glass	1	0	7·0	0·341	1	1·50
———— real aperture	1	0	4·5	0·335	1	1·29
Focus of the object-glass	23	7	5·0	7·700	25	3·00

Powers employed ..... 201, 324, 397, 461, 786, and 1000.

"These powers are not exaggerated, but have been measured with scrupulous care; so that you may be assured no future trial will give them less than the numbers here quoted."

II. A communication from the Astronomer Royal, containing the results of all the observations, which have been made at the Royal Observatory at Greenwich, of the sun's zenith distance, at or near the solstices, from the time of Bradley to the present time.

The number of observations is given; from which it appears, that, during the time of Bradley, there were 74 such observations of 7 summer solstices, and 61 observations of 7 winter solstices: during the time of Maskelyne, 317 observations of 32 summer solstices, and 220 observations of 31 winter solstices; and by the

present Astronomer Royal, 1560 observations of 19 summer solstices, and 882 observations of 17 winter solstices.

By taking the mean of the seven determinations of the summer solsticial zenith distances by Bradley, and also the mean of his seven determinations of the winter solsticial zenith distances, in seven successive years, beginning with the winter solstice of 1753, and comparing these values respectively with the values of the same elements, as deduced by taking the mean of the six last determinations of the summer solsticial zenith distances, and the mean of the five last determinations of the winter solsticial zenith distances, by Mr. Pond, the annual variation is found to be 0″,41455. By a similar mode of proceeding with the winter solstices, he finds the annual variation to be 0″,4787.

Mr. Pond then proceeds to direct the attention of astronomers to the difference in the values of the latitude of the Royal Observatory, as obtained from Bradley's solsticial zenith distances, and as derived from the solsticial zenith distances, deduced from his own observations within the last six years. He states the latitude, which results from Bradley's observations, to be 51° 28′ 40″,323; and that which is obtained from his own observations to be 51° 28′ 38″,077; the difference being 2″,256.

III. A communication from Sir Thomas Brisbane, consisting of observations of the moon, and moon-culminating stars, during the years 1829 and 1830, made at Makerstoun with a four-feet transit. Sir Thomas Brisbane states in the letter accompanying his paper, that "the observations were almost entirely made by Mr. Dunlop." The paper contains the observed differences in A.R. between the moon and the moon-culminating stars, observed before and after her culmination, and also the number of wires used in each observation.

IV. On the theory of the eye-glasses of telescopes; by Professor Littrow, Associate of the Society.

The author begins by taking the case of an eye-glass composed of any number of lenses placed at any distance from one another. He then deduces simple expressions for the magnifying power, the field of view, and the distance at which the eye should be placed, as also the equations which must be satisfied in order that the spherical and chromatic aberrations may be inconsiderable.

He then describes the manner of conducting the process, which he proceeds to apply to the eye-glasses in common use, namely, of one, two, and four lenses, in the following order:—

1. The common astronomical telescope, and the Galilean, or, as he calls it, the Dutch telescope. He here shews that the chromatic aberration cannot be destroyed, and other well-known defects of these constructions.

2. When the eye-glass has two convex lenses. Though in this telescope, a wire micrometer cannot be used, on account of its being requisite to place it between the lenses of the eye-glass, yet,

being perfectly achromatic, it has been used by Dollond, Ramsden, and Fraunhofer, for night telescopes or sweepers. The construction used by these artists is shewn from this theory to be the best for giving a large field of view.

3. Ramsden's telescope, with a convex and concave lens in the eye-glass. The theory of this instrument, which can be used with a wire micrometer, but cannot be freed from chromatic aberration, was imperfectly given by Ramsden in the *Philosophical Transactions* for 1783, p. 94, and is here deduced from the general equations, the results agreeing very nearly with those of Fraunhofer.

4. The common terrestrial telescopes, with four lenses in the eye-piece. Here results are deduced which have not been used by English or German artists, but, at the same time, it is shewn that those which have been used are consistent with the theory.

V. The reading of a paper by Francis Baily, Esq., on Lacaille's catalogue of 398 principal stars, was begun. The abstract of this paper will appear in the next Monthly Notice.

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *May* 13, 1831. No. 5.

THE following communications were read:—

I. Mr. Baily's paper, "on Lacaille's Catalogue of 398 principal Stars," was concluded.

In this paper Mr. Baily has entered into the merits of this celebrated catalogue. The method adopted by Lacaille for determining the right ascensions was that known by the name of *equal altitudes:* for when he commenced his astronomical career, the transit instrument was but little known, and not fully appreciated; and although it had been introduced into the observatory by Roëmer, yet it was soon abandoned for the mural quadrant, which at that time was considered a more manageable and accurate instrument, and capable of giving at one view both the right ascensions and the declinations. The instrument used for this purpose was a 3-feet quadrant: and he usually took about 14 or 16 altitudes on each side of the meridian. The culmination of the stars being thus determined, he compared them with *α Lyræ* or *Sirius* (whose absolute right ascension had been ascertained by frequent comparisons with the sun), and thus computed their right ascensions relatively to those stars. The declinations were determined with two different instruments: one a 6-feet sector, and the other a 6-feet sextant; the divisions of which were examined with great care by himself, and the trifling discrepancies noted and allowed for.

By the help of these instruments, Lacaille determined the positions of nearly 400 of the principal stars in the northern and southern hemisphere: and the catalogue which he thus produced, and which is the subject of the present memoir, is worthy of being placed in competition with those of his distinguished contemporaries. Mr. Baily has examined this catalogue with great care, and has discovered a few errors, which seem to have escaped the diligence of its illustrious author.

When Lacaille had finished his observations and his catalogue, he was at a loss for the means of publishing them; since his own limited income would not warrant the expense. He tried several modes of doing this, and at last agreed with his bookseller to compute for him an astronomical ephemeris for ten years, if he would print a sufficient number of copies for distribution amongst his scientific friends and correspondents. Such was the origin and cause of the *Fundamenta Astronomiæ*,—a work which was not

published for sale, and which can therefore only be obtained accidentally from time to time as it occasionally passes from the hands of those to whom it was originally presented. It is consequently very rare; and those who possess it ought (as M. Delambre emphatically expresses it) to preserve it as a precious relic.

As the catalogue has never yet been reprinted, in the extended and perfect form in which it exists in that work, Mr. Baily conceived that he should be rendering an acceptable service to astronomers in presenting it to them, thus corrected, through the medium of this Society, accompanied with a comparison of the places of all the stars visible in this latitude, with those given by Bradley; and a reference to every observation of every star; together with notes accompanying the whole. Mr. Baily has also mentioned another motive which induced him to examine the comparative merits of this catalogue at the present time: since above one-third of the stars are so situated that they cannot be observed in this latitude, on account of their great southern declination. These stars, therefore, he justly remarks, will afford a favourable opportunity of comparison with the same stars as observed by Sir Thomas Brisbane at his observatory at Paramatta; whose valuable and extensive observations are now in the course of reduction at the public expense; and thus enable us to determine, with considerable precision, the annual variation of at least 136 principal stars in the southern hemisphere. Mr. Baily closes his paper with a few remarks on the scientific life of Lacaille.

II. A letter from Mr. Dawes, dated April 23, 1831, of which the following are extracts:—

"I beg to call the attention of the Astronomical Society to an interesting circumstance respecting the triple star ζ Cancri. I am not aware of any published observations relative to the positions of the stars composing it, since those of Sir James South, made at Passy in 1825. Possibly, however, such may exist, and may render my present communication unnecessary, or, at any rate, less interesting.

"The evenings of the 19th and 20th of this month proving favourable for delicate observations, I directed a five-feet achromatic telescope to this object. This instrument was constructed for me last year by Mr. Dollond; and from the perfectly round, clean, and very small discs with which it exhibits the fixed stars, it is peculiarly adapted for the examination of very close and delicate objects. It is mounted equatorially, with horary and declination circles, each of two feet diameter, and is furnished with a position and parallel-thread micrometer, possessing a variety of magnifying powers, from 55 to 625. The instrument was fitted up with a special view to the examination of the positions and distances of the multiple stars. Each part of the micrometer screw-heads is equal to 0″,5559219."

Mean result.	Pos. of AB = 59° 13′ *nf* (16 obs.)	Dist. = 1″,095 (7 obs.)
	Pos. of AC = 60 17 *sf* (5 obs.)	Dist. = 5 ,592 (5 obs.)

After giving the observations, Mr. Dawes proceeds thus:—

" Now, if we compare these results with the measurements of Sir W. Herschel in 1781, and of Sir James South in 1825, a very extraordinary variation appears. In 1781·90, Sir W. Herschel's measure of the position of AB was 86° 32′ *nf.* In 1825·27, a mean of 43 measures (the means of the *six* different sets on as many nights, agreeing admirably together) gave as the position 32° 10′ *nf*, offering a difference of 54° 22′ from the position in 1781. *Now*, however, the angle lies as nearly as possible midway between the two, being 27° 19′ less than that of 1781, and 27° 3′ greater than that of 1825; while the distance, as measured by me, is only 0″,009 greater than the result of 15 observations by Sir J. South. It would therefore appear as if the motion had been performed in a *direct* sense (or *nf sp*) for perhaps thirty or forty years; and that the star B had then come to a stand, (or *appeared* to do so), faced about, and is now proceeding in the *opposite* direction, which is the same pursued by the star C. But this is an extravagant idea; and unless there exist observations in the intervening period to invalidate the supposition, I think we may arrive at a solution of the difficulty in a more simple manner; namely, that in the forty-nine years elapsed since Sir W. Herschel's measurement, the star B has performed *almost an entire revolution*, in a retrograde sense, or *np sf*, only about 27° or 28° being wanting to complete it.

" Mr. Herschel, in his notes appended to Sir J. South's valuable paper, forming the first part of the *Philosophical Transactions* for 1826, has mentioned an observation of this star by his father in 1802, ' at which time,' it is said, ' no measures could be procured.' Now, supposing this to be the only observation recorded during the interval, it may be asked, Would not Sir W. Herschel have been struck with any remarkable alteration in the relative positions of A and B, even supposing the circumstances were not such as to admit of measurements? To this it may be replied, that it is highly probable the star B would, about the year 1802, have arrived at that point of its orbit in which it would be nearly *opposite* to its place in 1781; and the stars differing but little in size, it might not be noticed, especially in unfavourable circumstances, which *preceded;* and, consequently, it might easily be imagined to have sustained but little, if any, alteration.

" The position of B now observed is the more remarkable, because, had it pursued the course formerly assigned, its angle relative to A would now be about 24° or 25° *nf.* That an error of 35°, or any thing like it, should be committed in my measurements, appears quite improbable; since, if we examine them, we shall find that the extreme difference of all the sixteen measures taken on the two evenings is only 3° 35′. And I may here observe, that in measuring both positions and distances, I always *derange* the former measurement so completely, that the situation of the wire could not by possibility be taken for a measure. Thus, each individual measure is not a previous one, altered and amended, but is entirely new and independent.

" It will be seen that the above observations corroborate the

presumed motion of the star C in *direction*, and indicate a considerable acceleration in it since 1825, compared with the *mean* velocity during the previous forty-two years; while the distance continues very nearly the same as it was at that date. Compared with Sir J. South's observations, the change of angle amounts to 7° 38′ in six years, or 1°,267 per annum; while, previously, the mean motion was supposed to be only 0°,5813. But in the observations appended to the measures by Messrs. Herschel and South, in 1822, we were forewarned to expect an acceleration, *if the motion were orbitual*. My observations of the star C, however, being made on one night only, may be liable to an error of one or two degrees, especially as the position of the star B, and its extreme proximity to A, render the measures of C difficult."

III. An Index to the Society's Catalogue, by Lieut. W. S. Stratford, R.N.; so arranged that the number of any star contained in the Catalogue may be found immediately, provided there be given the name of the constellation, and the letter by which the star is distinguished, or the number of the star in one of the following catalogues; viz. Flamsteed's, Piazzi's, Bradley's, Lacaille's, Fallows's, Zach's, &c., preference being given to each catalogue in the order of succession.

IV. A paper containing micrometrical measurements of 364 double stars, by J. F. W. Herschel, Esq.

The abstract of this paper, the reading of which is not yet completed, will appear in the next Monthly Notice.

J. MOYES, TOOK'S COURT, CHANCERY LANE.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *June* 10, 1831. No. 6.

THE following communications were read:—

I. Observed occultation of Jupiter and his satellites by the moon, June 1, 1831.

1. By the Astronomer Royal, giving the contact, immersion of Jupiter's centre, and total immersion, by four observers; and the emersions of Jupiter and the four satellites, by seven observers.

2. By Mr. Snow, containing the complete observations of all the immersions and emersions, made in Savile Row, together with the observed transits by which the clock error was determined.

Mr. Snow observes:

"Between the contact of the moon's limb with the planet, and the planet's disappearance, 1′ 32″ elapsed; and during that time no change of light, colour, or motion, took place in the planet, which remained uniformly of a rather more dusky colour than the moon. Both the planet and moon were in a violent state of undulation during the immersion; but the moon's undulation was seen quite distinctly upon the planet's disc, and differed, for that small arc, in no respect from the undulation of the rest of the limb. I watched very particularly for any projection of the planet upon the moon's edge, but could see none.

"It is perhaps worth mentioning, that the planet's second limb, during, and for several seconds after its final emersion, and in both states of the adjustment of the telescope, appeared to have a very considerable curvature towards the moon's dark limb. The planet, however, soon returned to a shape nearly spheroidal."

3. By Captain Smyth, containing the same observations. Captain Smyth also remarks:

"Although the emersions of the satellites were perfectly distinct, they were certainly not so instantaneous as those of the small stars; which I think was more owing to light than disc. Jupiter entered into contact rather sluggishly; but though the lunar limb was tremulous from haze, there was not the slightest loss of light. Faint scintillating rays preceded the emersion, which was so gradual, that, as the planet re-appeared, the edge of the moon covered it with a perfectly *even* and black segment, which cut the belts distinctly, and formed clear sharp cusps, slowly altering until the

whole body was clear. There was no appearance of raggedness from lunar mountains, and Jupiter's belts were superbly plain while emerging; but there was not the slightest distortion of figure, diminution of light, or change of colour."

In allusion to the deviation seen by Messrs. Ross and Comfield, which is inserted in the Memoirs, Captain Smyth mentions the following fact:

"On Thursday the 26th of June, 1828, the moon being nearly full, and the evening extremely fine, I was watching the second satellite of Jupiter as it gradually approached to transit its disc. My instrument was an excellent refractor, of $3\frac{3}{4}$ inches aperture, and 5 feet focal length, with a power of 100. It appeared in contact at about half-past 10, by inference, and for some minutes remained on the edge of the limb, presenting an appearance not unlike that of the lunar mountains coming into view during the first quarter of the moon, until it finally disappeared on the body of the planet. At least twelve or thirteen minutes must have elapsed, when, accidentally turning to Jupiter again, to my astonishment I perceived the same satellite *outside the disc!* It was in the same position as to being in a line with the apparent lower belt, where it remained distinctly visible for at least four minutes, and then suddenly vanished."

The same phenomenon was also observed on the same evening, at different places, by Mr. Maclear and Dr. Pearson.

II. A letter from Mr. Dawes to Mr. Herschel, giving observations of the double stars, 70 Ophiuchi, ξ Ursæ Majoris, 44 Bootis, γ Virginis, η and σ Coronæ, Castor, γ Leonis, and ε Bootis, made during the last and present year. Mr. Dawes is of opinion that the apparent discs are more affected by the aperture of the telescope than by any other circumstance; and that this is the principal reason why a reflector presents a smaller image of a fixed star than an achromatic of equal illuminating power.

III. The reading of Mr. Herschel's paper on the measures of 364 double stars was completed.

This paper contains the micrometrical measures of the angles of position and distances of 364 double stars, observed by Mr. Herschel with the seven-feet equatorial in his possession at Slough, the same which was used by Sir James South in his observations at Passy, and in a part of the measures of double stars in the *Philosophical Transactions* for 1824. The individual measures, being too numerous, are not stated; but the mean results of each night's observation are set down in tabular order, with a weight attributed to each, indicative of the degree of confidence which the observer himself attributes to them, and with notes attached, descriptive of any peculiar circumstances in the observation proper to be recorded. They comprise the results of 735 sets of measures, or from 6000 to 8000 individual observations, obtained under all atmospheric circumstances, in the years 1828, 1829, and 1830. Almost all the stars observed are taken from the great catalogue of Struve.

The author prefaces his observations by a comparison of his results with those already obtained by other observers in the cases where his stars *have* been observed by others, and draws a conclusion not unfavourable to the general accuracy of his angles of position; although, in some individual cases, considerable discrepancies and even grievous errors are admitted. In the course of this comparison he is led to point out some stars as having so materially changed, at least apparently, that he is induced to recommend them for further observation, as being possibly of a binary nature. With regard to his distances, he professes himself much dissatisfied, owing to an imperfection in the micrometer attached to the instrument, which is the same with that used in all its former measurements, and of which the cause has been detected too late to remedy the evil.

After noticing some peculiarities in his mode of observation, and in particular his use of a red illumination of the wires, which he regards as a great improvement, he enters into a more particular examination of the bearing of his present results on the theory and history of the following stars, whose motions he considers as fully demonstrated by them, although some of them had previously been brought into question.

η Cassiopeæ.	γ Virginis.	39 Draconis.
η Persei.	η Coronæ.	ε^1 Lyræ.
Castor.	μ^2 Bootis.	ε^2 Lyræ.
ζ Cancri.	49 Serpentis.	ζ Sagittæ.
ω Leonis.	σ Coronæ.	61 Cygni.
γ Leonis.	μ Draconis.	δ Equulei.
ξ Ursæ.	70 Ophiuchi.	ζ Aquarii.

Among these the most remarkable of his conclusions refer to Castor, ζ Cancri, ξ Ursæ, γ Virginis, and η Coronæ. In the cases of Castor and γ Virginis, he is enabled, by the kindness of Professor Rigaud, to produce observations of their positions by Bradley and Pound, which are peculiarly valuable, as they carry back the history of these stars upwards of a century, and enable us to form a much better judgment than heretofore of their orbits, both which appear to be ellipses of considerable elongation. He describes a very ready and easy graphical process by which these orbits may be approximately laid down, and exemplifies it on γ Virginis, respecting which he concludes that the present approach of the stars, and increase of their angular velocity, will still go on for several years, until their distance is reduced to less than a single second, which, considering the brightness of both individuals, will render this a single star to all but the very finest telescopes. Castor he also considers likely, ere very many years have elapsed, to become a close double star, and again to open to a much more considerable distance than at present.

In the case of ζ Cancri, he is led by his observations to conclude that the motion is retrograde instead of direct, and much more

rapid, so that this star has nearly completed a whole revolution. This conclusion is fully confirmed by his observations of the present spring (1831), and also by the observations of Mr. Dawes, which have been communicated to him very recently, and which agree in a very remarkable manner with his own, and actually suffice to trace the bimestral motion of the star, as had been previously done in the case of ξ Ursæ. η Coronæ, too, offers, if all the observations can be trusted, a still more remarkable instance of quick rotation, being already considerably advanced in its *second* revolution since Sir Wm. Herschel's first discovery of it; but this will require further confirmation, owing to the extreme difficulty of the measures. The periods of these two stars may be stated respectively at 55 and 43 years; that of ξ Ursæ at 56½, which last determination agrees nearly with that of M. Savary, who has assigned 58½ years for this element. The period of 70 Ophiuchi has been determined by Professor Encke at 73·862 years.

Lastly, Mr. Herschel subjoins some practical remarks on the management and action of telescopes, and takes occasion to introduce a set of measures of the positions of Saturn's satellites, taken under remarkably favourable circumstances, and also a single observation of the place of the comet of 1830, the only one he could succeed in procuring.

In a subsequent letter received from Mr. Herschel, he alludes to a new method of taking the angles of position, viz., by reflected as well as by direct vision. He conceives that this method possesses two capital advantages: 1st, That the quantity directly measured is double the quantity sought, by which, of course, the error of determination is halved; and, 2dly, That the error of the zero is destroyed altogether, the double arc being given by the difference of readings in the limb of one and the same circle, maintained in one and the same position. Mr. Herschel also adds, that subsequent and very satisfactory measures of η Coronæ fully confirm the conclusion above mentioned with regard to the revolution of that star.

IV. On the dependence of a clock's rate on the height of the barometer, by the Rev. Dr. Robinson.

The rate of a clock of good workmanship may be assumed to depend on three things; first, the rate at a given temperature and barometric pressure: secondly, on the variation of temperature, as shewn by the thermometer; and thirdly, upon the atmospheric pressure, measured by the barometer. The variation of temperature not only affects the materials of the pendulum, but, along with the atmospheric pressure, greatly modifies the action of the air in the way of *buoyancy* and *inertia*, &c. Possibly, the irregular action of the wheelwork, the diminution of arc from the thickening of the oil on the pallets, and even the hygrometric state of the air, may sensibly alter the rate of a clock; but the present memoir is confined to the consideration of the first-mentioned sources of error.

As the changes are minute, Dr. Robinson formed equations of condition, where the quantities sought were the rate of the clock at

49° of the thermometer, and 29·5 inches of the barometer, and the retardations corresponding to a rise of 1° and 1 inch in each of these instruments respectively. The absolute gain or loss of the clock was determined with the utmost care.

" A thermometer placed in the clock-case, with its bulb three inches before the pendulum rod, and on a level with the cover of the jar, and a barometer with its cistern at the same level, were noted morning and evening at half-past nine; a time chosen, not merely as likely to give mean results for the whole day, but also because it nearly bisects the average period of evening observations. The thermometer was read through a square of plate glass, cemented in the door of the case; and this being screwed close, (as described in the *Armagh Observations* for 1828,) all free communication with the air is precluded, and the changes of temperature within it are slower and more regular than would be possible in clocks of the ordinary construction. This made observations at other than the stated periods unnecessary. The barometer was observed whenever its movements seemed irregular, and the mean for the day corrected, if necessary, by interpolation."

Dr. Robinson then shews that the equations, when treated by the method of least squares, give, for the gaining rate of the clock at the standard temperature and pressure, $0^s,263$; for the gain by an increase of 1° in the temperature (his clock was over compensated), $0^s,069$; and for the gain by a depression of 1 inch in the barometer, $0^s,241$. As the mere effect of the air's buoyancy on the mercurial pendulum is $0^s,15$ for a change of 1 inch in the barometer, the remainder is due to the inertia of the air carried along with the pendulum in its oscillations.

Dr. Robinson finds that the barometrical pressure has no sensible effect upon the *arc of vibration*, and, consequently, does not affect the clock through this cause.

With respect to the barometric variation of rate, having once determined its co-efficient, nothing is easier than to allow for it when any sudden change occurs: it may, however, be corrected mechanically with the utmost facility. A rise in the barometer tends to make a clock go slower. Suppose a syphon barometer to be attached to the pendulum, then a rise in the barometer will transfer a portion of the mercury in the syphon to the tube, and the effect will be the same as if a small weight were shifted from the syphon end to the tube end of the barometer. Now if the syphon be so adjusted to the pendulum, as to bore and situation, that this alteration of the mercury in the barometer will accelerate the rate as much as the increase of the air's buoyancy and inertia retard it, the clock will be unaffected by any variation of the atmospheric pressure.

Dr. Robinson shews how the syphon barometers (he places two, one on each side of the pendulum rod) may be constructed and adjusted for any particular case.

" I had previously recognised the influence of the barometer on the clock before the mercurial pendulum was applied; and, without

employing the method of minimum squares, satisfied myself that the effect was even greater, being nearly 0·3 for an inch. In examining this point for any given clock, it is however to be remembered, that it is always necessary to make the probable errors of observation considerably less than the quantity sought; otherwise, no conclusive result can be obtained. This may be done, either by taking the rate for intervals of several days, or by observing several stars on each night."

A List of Stars observed with the Moon, in the present year, at the Royal Observatory, Greenwich.

1831.		h. m. s.	1831.		h. m. s.
Jan. 6.	Spica Virg.	13 17 6,08	Feb. 26.	48 Leonis	10 26 25,46
	☽ 2 L	14 2 43,42		o^1 Sextantis	10 37 44,26
7.	Spica Virg.	13 17 6,94		o^2 ——	10 38 58,17
	☽ 2 L	14 50 2,08		☽ 2 L	10 54 24,16
24.	111 Tauri	5 15 34,20	Mar. 23.	☽ 1 L	8 45 15,92
	☽ 1 L	5 24 33,76		π^3 Cancri	9 6 40,57
	N Tauri	5 38 35,46	27.	(50) Leonis	11 15 29,88
	χ^4 ——	5 54 27,40		(77) ——	11 20 6,86
25.	☽ 1 L	6 27 32,76		υ ——	11 29 8,96
	G Geminor.	6 41 7,24		☽ 1 L	12 13 22,98
	(281) ——	6 48 53,34	April 20.	☽ 1 L	9 24 42,42
	ξ ——	6 55 6,04		ψ Leonis	9 35 40,74
26.	☽ 1 L	7 30 6,74	May 22.	☽ 1 L	13 18 27,40
	g Geminor.	7 37 22,62		β^3 Virginis	13 28 2,80
Feb. 5.	1 β Scorpii	15 56 46,70		(174) ——	13 36 25,84
	☽ 2 L	15 8 6,62	24.	λ Virginis	14 11 17,78
	Antares	16 20 12,40		(127) Libræ	14 29 20,18
19.	☽ 1 L	4 4 11,04		μ ——	14 41 23,18
	h^3 Tauri	4 13 51,36		☽ 1 L	14 53 6,26
	σ ——	4 18 22,86	25.	ξ^3 Libræ	15 22 29,04
	ϱ ——	4 25 34,94		γ ——	15 27 24,72
				☽ 1 L	15 41 37,50

N.B. The Astronomer Royal having kindly offered to furnish the Society, from time to time, with the observations of moon-culminating stars, made at Greenwich, the first series is here given for the present year; and they will be continued in the subsequent Monthly Notices, as they are received; by which means they will become more speedily accessible to those persons who are desirous of making comparisons of this kind.

J. Moyes, 28, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

Vol. II. *November* 11, 1831. No. 7.

THIS was the first meeting after the long vacation; and the following communications were read: viz.

I. Observed Occultations and Eclipses of *Jupiter's* Satellites, by Mr. Maclear, of Biggleswade, from May 1830 to the present month.—These observations were made as usual, with the Wollaston telescope, and will afford means of comparison with similar observations made in other parts of the world.

II. Three Observed Occultations, in the months of May and June in the present year; and Five Observed Eclipses of *Jupiter's* Satellites, in the months of August, October, and November. By Mr. Snow.—These observations were made at Saville Row, London. In the eclipses recorded on the 3rd of November, the 4th satellite emerged quite close to the 1st, which made the latter appear as if it had suddenly become double. It was an interesting phenomenon.

III. Observations of the Occultation of *Aldebaran*, on the 23rd October. By Mr. Holehouse.

"The telescope was a seven-feet achromatic, by Tulley, with a power of 162, adjusted to the star. The atmosphere was free from clouds, and clear. I saw the moon steadily approach the star, until the star appeared to cling, half hidden by the moon, for about 4 or 5 seconds, by estimation, when it suddenly disappeared, leaving in my mind little doubt that the appearance was caused by the refraction of the moon's atmosphere."

IV. Observations of the Right Ascensions and Polar Distances of the Planets *Uranus*, *Jupiter*, *Vesta*, and *Mars*, from September to December, 1830. By M. Bianchi. In a Letter to Professor Airy.

M. Bianchi made his observations with a meridian circle of 3 feet, having a 5-feet telescope magnifying about 100. The apparent right ascensions and north polar distances are given, together with the differences arising from a comparison of their places, as given in the *Berlin Ephemeris*. The observed right ascension of *Uranus* is less than its computed right ascension, by a quantity varying from $1^s,12$ to $2^s,09$, and its polar distance is less, by a quantity varying from $4'',81$ to $12'',91$. The difference in the right ascension of *Jupiter* varies from $-0^s,06$ to $+0^s,70$, and in polar distance from $+0'',36$ to $-6'',43$. The difference in the right ascension of *Vesta* varies from $-0^s,56$ to $+0^s,36$, and in polar

distance from $-2''{,}25$ to $-17''{,}20$. The difference in the right ascension of *Mars* varies from $-0^s{,}43$ to $+1^s{,}02$, and in polar distance from $-14''{,}25$ to $+7''{,}64$. M. Bianchi regrets that he has not been able to make more observations; and states, as his reason for not attending sooner to the circular issued by this Society, that his duties as instructor of mathematics to the young prince prevented his attendance at the observatory at an earlier period.

V. Extract of a Letter from M. Cauchoix to Mr. Lubbock, dated October 1831.

" I have just finished another object-glass, of the same dimensions as that which Sir James South is now mounting, and which appears to me as perfect. I used for it one of the three pieces of glass which were set apart for the first object-glass, and I have adapted to it a new disc of flint-glass. A trial of it with *Jupiter* does not detect any flaw, either in the flint or crown glass. I hope also to be able to make a third glass of similar dimensions, as well as another glass of the same size as that which Mr. Cooper has lately bought of me. I have likewise another kind of telescope, which I have made for these two or three years, where *rock-crystal* is substituted for the crown-glass, by which means the focus is considerably shortened, and the brilliancy and clearness of the image greatly increased. But, at present, I have not been able to make them of larger diameter than about $5\frac{1}{4}$ English inches."

VI. A Catalogue of Stars, observed with the Moon, from June to October, 1831, at the Greenwich Observatory. From the Astronomer Royal: —

1831.		h	m	s
June 20	☽ 1 L	14	36	51,54
	2 ξ Libræ	14	48	5,08
21	☽ 1 L.	15	24	52,90
	η Libræ	15	35	3,78
	θ Libræ	15	44	42,04
24	☽ 1 L.	17	56	25,48
	(21) Sagittar.	18	15	48,16
	(94) Sagittar.	18	22	26,90
July 22	☽ 1 L.	18	30	45,98
	ξ^1 Sagitt.	18	48	1,20
	(316) Sagitt.	19	0	33,44
	d Sagitt.	19	8	28,24
Aug. 19	(112) Sagitt.	18	26	22,26
	r Sagitt.	18	40	35,06
	ξ^1 Sagitt.	18	48	14,53
	☽ 1 L.	19	3	18,36
Sept. 22	(120) Piscium	0	27	20,40
	☽ 2 L.	0	59	10,66
Oct. 16	A Aquarii	21	15	40,76
	☽ 1 L.	21	49	41,44

Oct. 19	.....	(227) Piscium..	23	46	54,06
		(270) Piscium..	23	57	10,50
		10 Ceti	0	18	43,98
		☽ 1 L.....	0	30	50,10
21	.....	(144) Piscium..	1	32	29,34
		o Piscium..	1	37	16,52
		ξ^1 Ceti.....	2	4	50,84
		☽ 2 L.....	2	27	0,48
23	.....	θ^1 Tauri	4	19	45,22
		θ^2 Tauri	4	19	50,90
		Aldebaran	4	27	3,40
		☽ 2 L.....	4	29	38,98
27	.....	☽ 2 L.....	8	40	44,32
		β Leonis	11	41	16,16
28	.....	☽ 2 L.....	9	38	12,70
		Regulus	10	0	13,32

VII. A paper on the Orbits of Binary Stars, by Sir J. F. W. Herschel, was commenced. The abstract will be given after its completion.

J. Moyes, 28, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

Vol. II. *December* 9, 1831. No. 8.

THE following communications were read: viz.

I. On the *proper motion* of the Fixed Stars, by Francis Baily, Esq.—The author sets out with lamenting the little attention that has been paid to this subject by preceding astronomers; and though he by no means pretends that this paper should be considered as a perfect essay on it, yet he hopes it will be sufficient to induce the practical astronomer to turn his attention to this neglected branch of the science. The most satisfactory mode of determining the proper motion of a fixed star, the author remarks, is by a comparison of two catalogues of distant epochs; for if the difference in its position, at the two epochs, does not correspond with the amount of the precession of the equinoxes, there is good reason to suspect that the star has a proper motion of its own, particularly if the difference exceed what may be fairly attributed to the errors of observation. But even this is not always a sure guide, unless the interval be considerable; for the errors of the instrument, the unavoidable mistakes committed in the reduction of the stars, and the errors of the press, are occasionally mixed up in such a manner that we are frequently at a loss to know where the truth lies. Moreover, the differences in the constants employed in the reduction of the observations themselves may mislead us, and induce us to suspect a proper motion, when there is, in fact, no foundation for such an opinion. *Two* catalogues, therefore, are not always enough to enable us to decide with confidence that any particular star has a proper motion of its own; a *third* becomes necessary to determine the question with the requisite degree of accuracy; and where these are discordant, a *fourth* is absolutely essential, in order to shew where the error exists.

Mr. Baily then proceeds to state, that he has selected the catalogues of Bradley and Piazzi for determining the proper motion (μ') of any proposed star for the *first period*, viz. from 1755 to 1800, and the catalogues of Piazzi and Pond for the proper motion (μ'') for the *second period*, viz. from 1800 to 1830; at the same time stating, that he has also adopted some recent determinations in right ascension, by Professor Airy and Dr. Robinson, in addition to those of Mr. Pond. The formulæ by which the proper motions for these two periods are deduced are as follow; viz.

$$\mu' = \frac{P - B}{45} - \frac{p + \pi}{2}$$

$$\mu'' = \frac{S - P}{30} - \left(p + \frac{p - \pi}{3}\right)$$

where P denotes the place of the star in Piazzi's catalogue, B the place of the star in Bradley's catalogue; p the annual precession in 1800, π the annual precession in 1755, both taken from M. Bessel's catalogue in the *Fund. Astron.*; and S the place of the star for the year 1830, the right ascensions *being reduced to the same equinoctial point* as those of B and P.

It is in this manner that Mr. Baily has compared the places of all those stars which are known (or which have been supposed) to be affected with an annual proper motion of not less than about 0″,50 of a great circle, and has given a list of upwards of three hundred of such stars, with the amount of their annual proper motion (in right ascension and declination) for the two periods above mentioned. The author remarks, that when the annual proper motions of any given star thus deduced, for the two periods, correspond with each other, there is every reason to believe that such proper motion is correct; but that where they differ, (and this is by no means a rare occurrence, at once shewing the difficulty of the subject,) the probable conclusion is, that such stars have very little proper motion, or perhaps none at all; and that, at all events, further observations are necessary to decide so delicate yet so important a point. Mr. Baily concludes by remarking, that "our "information is at present but slight, and not always satisfactory. "When future observations shall have increased our stock of know-"ledge, the subject may probably be taken up by others, who will "have better means of following it up more in detail than I have "been able to do with the present scanty materials."

II. The reading of Mr. Herschel's paper on the Orbits of Binary Stars was continued; but as it could not be finished this evening, the conclusion was deferred till the next meeting.

After the meeting, Mr. Bate exhibited a machine for the illustration of the precession of the equinoxes. It consists of a pair of flexible hoops or rings, about nine inches diameter, representing a globe mounted on an axis which forms its poles, and to which a rapid motion is given, (being the same construction as is usually employed to shew the enlargement of the equatorial diameter by the centrifugal force.) The axis of these hoops centres in a brass meridian, which is also mounted in delicate vertical centres in a wooden frame, to which the axis of the hoops is inclined at an angle of $23\frac{1}{2}°$, a clock-spring movement is attached to the axis of the hoops, and the whole is carefully balanced, and stripped of friction as far as possible.

The clock-movement being wound up and restrained from action by a small click or trigger, on the removal of this click a very rapid motion, from west to east, is given to the inclined axis and flexible hoops, the upper pole of which becomes gradually depressed, by which depression the flexible hoops assume the figure of an oblate spheroid, in the usual manner. When this is acquired, the brass meridian receives a very slow movement from east to west, and it is

the retrograde motion of this meridian which is charged with representing the precession of the equinoxes.

Baron de Drais also exhibited two instruments; one for converting mechanically the area of any figure of a regular form into the corresponding area of a triangle, square, or parallelogram: and the other for *clearing the distance* in lunar observations, without the aid of computation.

Stars observed with the Moon, at the Royal Observatory, Greenwich.

1831.		h	m	s	
Nov. 13	☽ 1 L	22	19	22,86	
	70 Aquarii	22	40	45,60	
	K Aquarii	22	45	43,80	
15	η Piscium	23	40	27,84	
	24 Piscium	23	45	27,32	
	P Piscium	23	51	13,92	
	☽ 1 L.	0	3	55,90	
19	☽ 2 L.	3	58	29,40	
	48 Tauri	4	7	33,30	
	γ Tauri	4	11	33,16	Sky hazy.
	π Tauri	4	18	26,10	
	Aldebaran	4	27	36,14	
26	☽ 2 L.	11	10	11,24	
	β Virginis	11	43	23,59	

J. Moyes, 28, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *January* 13, 1832. No. 9.

THE following communications were read :—

I. The conclusion of Sir J. Herschel's paper on the Orbits of Binary Stars.

The author states his object in this paper, (which is intended by him as a supplement to his measurements of 364 double stars, lately communicated to this Society,) to be the explanation of a process by which the elliptic elements of the orbits of binary stars may be obtained from such imperfect observations as we possess, both with greater facility, and with higher probability in their favour, than by any system of computation hitherto explained.

The author divides his subject into two parts: first, the general statement of his method of investigation; and secondly, its application to the cases of some of the most remarkable binary stars known. In the first of these divisions, after enumerating the elements to be determined, and stating in general terms the formulæ of elliptic motion as applicable to the circumstances of the inquiry, he proceeds to consider the points in which the chief difficulty and delicacy of the inquiry itself resides, which he regards as arising not so much from the analytical intricacy of the equations to be resolved, as from the extreme imperfection and conflicting nature of the data afforded by observation. Of these, he considers the measured distances as especially liable to error, and, indeed, so insecure as to render it quite indispensable to discard them altogether from the data employed, and to rely, for the determination of the elements, solely on the observed angles of position and the intervals of time included between the epochs of observation.

It is, therefore, on a consideration of these alone that the processes explained in this paper are grounded. But the observed positions themselves, although much more to be depended on than the distances, are yet liable to errors too considerable to allow of our selecting any given combination of picked observations as data, to the exclusion of others. All the observations we possess must, he remarks, be treated according to one regular process, so as to educe from their assemblage, not several different and mutually-opposing orbits, such as would result from combining them in arbitrary groups, but rather one single resulting orbit, which they shall all agree in supporting, so far as their inherent errors will permit them to agree in supporting any orbit at all.

The processes described in the present communication for accomplishing this object are essentially graphical. They assume the Newtonian law of gravitation and its consequences, the laws of elliptic motion, and may be divided into three separate steps or stages: first, one having for its object the purification of the observations themselves from all that amount of error which can be detected and eliminated by mutual comparison; secondly, the graphical construction of the actual curve into which the orbit of one star about the other, regarded as fixed, appears projected on the visible surface of the heavens, which curve ought to be an ellipse, but not of necessity having the fixed star in its focus; thirdly, from the visible orbit so laid down, the third and last step consists in deducing, by a proper system of combined measurement and computation, the elliptic elements of the true orbit as it exists in space, which must then be compared with all the observations we possess.

The preliminary preparation (or purification from palpable error) of the observations is accomplished by laying down, on a chart of engraved squares, the observed angles of position in the direction of one co-ordinate, while the times of observation are measured off in that of the other. Thus a series of points will be obtained expressive of the *rough* or *observed* angles of position at all the epochs of observation. A curve, called by the author the "interpolating curve," is then prescribed to be drawn, not *through*, but *among* these points, according to certain precepts; and by its aid a series of *rectified* angles of position, corresponding to equal, quinquennial, or decennial intervals of time, is obtained by simple reading off and tabulation. Moreover, tangents being drawn to this curve at its points, which correspond to every fifth or tenth year, the angular velocities (also *rectified* or purified from palpable error) are obtained. Now, these being known, the corresponding apparent distances (which, by the laws of elliptic motion, are inversely as the square roots of the apparent angular velocities,) become also known.

In the course of the statement of this process, the author takes occasion to examine the received processes of interpolation, as applied to such cases, which he considers defective on two distinct grounds: first, that no curve "of a parabolic nature," as usually prescribed, nor *any* other curve than the transcendental one, which expresses the angle of position in terms of the time according to the *true laws* of elliptic motion and the *true data* in the particular case in question, has any claim to preference; and secondly, that even were such a parabolic curve theoretically correct, it would lead to enormous practical errors to subject it to a rigid condition of passing through points liable to such errors as those actually laid down by observation.

The mode of drawing such a curve, in the first instance approximately, and of correcting it afterwards, so as to lead, by an easy and certain process, to its true form, as corresponding with the laws of elliptic motion, are stated at length, partly in the general or introductory part of this paper, and partly in the application of its

principles to the case of a particular double star, 70 *Ophiuchi*, in which the first approximation is insufficient.

When the angles of position and corresponding or *derived* distances are once obtained for intervals sufficiently numerous, it is easy to lay them down on paper, and thus to construct a curve which will express, infinitely better than could have been done by using *observed* positions and *observed* distances, the apparent orbit of the star.

If the points so laid down fall on the circumference of an exact ellipse, all is well; if not, an ellipse must be drawn, not *through*, but *among* them, as well as the case will permit; and *this ellipse* will be the general and single representative of all the data, after passing through these successive processes of rectification and mutual adaptation.

This ellipse existing on paper must be measured, its situation with respect to the meridian, &c. found, and its areas described in known times, either actually cut out and weighed, or an equivalent arithmetical process substituted for the use of the balance; and from such weights and measurements, by the aid of formulæ, which the author states, the true, final, elliptic elements of the real orbit, and its situation in space, are determined.

He then proceeds to apply this mode of operating to the cases of five of the most remarkable binary stars known; viz. *γ Virginis*, *Castor*, *σ Coronæ*, *ξ Ursæ*, and 70 *Ophiuchi*. In those of the first two he is aided by observations by Bradley, made upwards of a century ago, in the nature of allineations with known stars, with which most valuable data he was furnished by the kindness and research of Professor Rigaud. His results tend to indicate (with more or less certainty and precision) an approach of both these double stars to their respective perihelia; the former about the year 1834, the latter about 1855; and in each case he considers it probable that the actual proximity of the two component stars will be extreme, and the apparent angular velocity proportionably rapid, insomuch that in the case of *γ Virginis* an angle of 68° may be described in a single year.

That the degree of credit which may attach to these predictions (if such they can be called) may be fairly estimated, he annexes, in a tabular form, comparisons of his elements with actual observation.

The case of *σ Coronæ* is remarkable only for the precise coincidence of the angles of position, as *rectified* by the process of interpolation used, with a true ellipse; but the star is excessively difficult, and the errors of observation necessarily great. This star is also approaching its true perihelion, which it will attain about 1835.

The case of *ξ Ursæ* leads, by a first approximation, to an orbit so nearly coincident with M. Savary's, (though decidedly inferior to it in its power of representing the earlier observations), that the author considers it unnecessary to go through a second process, which would most probably lead almost precisely to the same conclusions with those of the French geometer.

In the case of 70 *Ophiuchi*, the first orbit arrived at, by means of a curve arbitrarily drawn to interpolate the angles of position, departs too far from an ellipse, and the elements deduced represent the observations too widely to remain satisfied with it. It becomes necessary, therefore, to correct the work, or execute a second approximation; which done, an orbit is deduced representing, within the limits of error of good observations, the whole series of angles of position which have been obtained by micrometric measurement. The author remarks, as a singular fact, that the elements so obtained differ materially from those of Professor Encke for the same star, especially in the period, in which the discrepancy amounts to six years, while yet the two orbits represent the observations equally well throughout nearly five-eighths of the whole ellipse.

Since the distances are not at all considered in this process, the major axis must be determined by comparing the radii vectores of the ellipse deduced, in parts of an arbitrary scale, with observation, so as to convert such parts into seconds of visible distance. This comparison, properly conducted, by comparing the sum of all the observed distances with that of all the measured radii, will give a co-efficient of reduction whence the axis can be easily had. When obtained, the theoretical distances can be computed without farther reference to observation, and thus become a check (so far as the observations can be depended on) on all the foregoing work. In the case of γ *Virginis*, the measured distances have diminished, since the earliest observations we possess, from between 6″ and 7″ to less than 2″. This diminution, which has been regularly progressive, is faithfully represented by the computed radii; so that a very considerable corroboration is thus afforded both to the actual orbit arrived at, and to the probability of a yet much nearer appulse, in which the stars will be seen separated in none but the finest telescopes.

The periods of the five double stars whose elements are here computed are as follow:—

γ Virginis	513 years.
σ Coronæ.....	287
Castor	253
70 Ophiuchi	80
ξ Ursæ.....	58

The author concludes this paper by stating, that he has received great assistance in the pretty extensive numerical computations into which the subject has led him, from the contrivance and use of a piece of mechanism, by which the solution of the equation between the mean and eccentric anomalies in the theory of elliptic motion,

$$u - e \cdot \sin u = nt.$$

is obtained by mere inspection and reading off, and that the principle of this mechanism is applicable to other and more complicated cases.

II. Account of the Occultation of 119 and 120 *Tauri* by the Moon, on December 18th, 1831. By Sir James South. In a Letter to Mr. Baily.

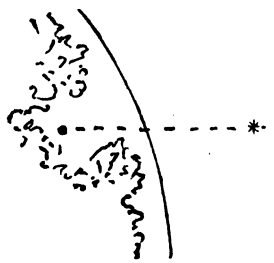
"The night of Sunday, December 18th, was remarkably fine, the air clear, and the stars unusually steady. The barometer stood at 29·35 inches, and the thermometer (attached to the transit circle) 45°,0. At about $0^h\ 45^m$ the five-feet equatorial, armed with a power of 133, was directed to 119 *Tauri*. The star was exquisitely defined, and very steady. The moon was within 10 hours of the full: her dark limb was of course invisible; but, by carrying the eye along the apparent upper limb towards the apparent lower (both of which were illuminated), the situation of the unillumined border might be determined without much chance of error, and the moment the star reached the presumed limb, which it did at $0^h\ 57^m\ 15^s{,}75$, it instantaneously disappeared, and a more satisfactory observation I never made. At about $1^h\ 15^m$ I returned to the instrument, and found [illegible] *Tauri* fast approached by the moon, the star remarkably steady, [illegible]d the moon unusually so. The same eye-piece was used as at [illegible]e occultation of the previous star; nor was its adjustment in the *lightest* manner varied. On the moon's presumed unillumined border touching it, its splendour remained unimpaired; and having traversed the generally unillumined portion of the disc, presented itself midway between two illuminated mountains, commanding, as it were, the entrance to an unilluminated bay, as represented in the accompanying diagram: it moved majestically along, bisecting by its course the angle of the bay, till, inosculating with an illuminated ridge forming the angular termination of the bay, it became invisible at $1^h\ 27^m\ 5^s{,}86$."

AB the unillumined limb.
CD the rough illuminated edge.
E and F illuminated mountains at the entrance of the *un*illuminated bay.
The dotted line represents the star's course. Its disappearance was at the angular point.

The same phenomenon was observed by Sir James South's assistant, and also by Mr. Richardson and Mr. Simms, at Greenwich. There will be an occultation of the same stars on the 9th of March, at $10^h\ 13^m$ and $10^h\ 49^m$ sidereal time, or $11^h\ 2^m$ and $11^h\ 38^m$ mean time.

Since the above was written, Sir James South has received the following sketch of the appearance of the path of the same star, as observed by Mr. Simms, at the Royal Observatory of Greenwich. The star disappeared at the black dot, and must have passed the

dark limb of the moon at least 40 seconds. The telescope used was a dumpy reflector, by Cuthbert.



III. Observation of Occultations of Stars by the Moon, made at Bedford, by Captain Smyth, between the months of January and December, 1831. Those made in the month of December are subjoined.

Date.	Star, &c.	Immersion.	Emersion.	Remarks.
1831.		h m s	h m s	
Dec. 7	4's 1st satel.	———	0 16 30,55	Seen through driving clouds in the S.W. Wind also S.W.
17	γ Tauri.	21 17 ?	22 08 ?	Most unfavourably seen through clouds, and only inserted to shew the probable state of the prediction.
—	99 Tauri.	———	2 40 ?	
18	119 Tauri.	0 57 17,00	1 54 14,95	Both well seen. Immersion between two protuberances.
—	120 Tauri.	1 26 41,99	2 28 30,25	Imm. very good, but hazy at emersion.
22	A small star.	13 36 26,10	———	Barely perceptible in the lunar light.
—	α Leonis.	13 40 27,12	———	Excellent. Projected 1½″ on the bright limb. Emersion lost.
23	4's 1st satel.	———	23 40 00,10	Very good observation.

IV. Observations of Occultations and of Stars observed with the Moon, at the Cambridge Observatory, during the year 1831. By Professor Airy.

*** Professor Airy having kindly offered to communicate these observations monthly in future, they will appear with those made at Greenwich.

Occultations observed at Cambridge Observatory, in the year 1831.

Astronomical latitude, about 52° 12′ 50″.
Longitude, 23s,54 East of Greenwich.

Jan. 26. Disappearance of *f* Gemin. at the dark limb.

	h m s	
Airy	6 38 30,60	Cambridge sidereal time.
Rothman ...	6 38 30,50	Good obs.

June 1. Disappearance of Jupiter at the bright limb.

	1st limb of Jupiter. h m s	2nd limb of Jupiter. h m s
Airy.....	17 46 41,87	17 48 22,65
Rothman.....	17 46 46,35	17 48 21,85
Whewell.....	17 46 42,51	17 48 15,77

Reappearance of Jupiter at the dark limb.

1st limb of Jupiter.	h m s	2nd limb of Jupiter.	h m s
Airy.....	18 53 35,62 (good)	Airy.....	18 55 19,20
Rothman	18 53 35,87	Rothman... .	18 55 20,87
Whewell	18 53 36,85	Whewell.....	18 55 18,35

Oct. 21. Disappearance of ξ^2 Ceti at bright limb ..... 22 35 33,11 } Airy.
Reappearance of ξ^2 Ceti at dark limb ..... 23 28 53,84 }

Pretty good.

23. Disappearance of θ^1 Tauri, at bright limb 23 36 47,45
Disappearance of θ^2 Tauri 23 47 16,05

		h	m	s
Oct. 23.	Disappearance of 75 Tauri	23	54	3,08
	Reappearance of θ^2 Tauri, at dark limb	0	14	14,86
	Reappearance of 75 Tauri	0	26	1,15
	Disappearance of Aldebaran	3	6	52,49
	Reappearance of Aldebaran	4	13	32,40

All good: those of Aldebaran excellent. Deep projection at the immersion.

Nov. 26.	Reappearance of Saturn at the dark limb. First appearance of light	10	3	46,46
Dec. 17.	Reappearance of γ Tauri, at the bright limb...	22	11	41,54
	Disappearance of Aldebaran at the dark limb...	4	45	10,50

The observation of Aldebaran very good.

22. Disappearance of Regulus at the bright limb.

	h	m	s	
Airy	13	42	55,06	(very good)
Whewell	13	42	53,66	+
Another observer	13	42	55,08	

All the observers saw the star hang on the limb, and in some degree projected on the disc. Mr. Whewell considered the time to be a large fraction of a second later than that set down.

Transits of the Moon and Moon-culminating Stars, observed at Cambridge Observatory, in the year 1831.

Date.	Name.	Clock Time of Transit. h m s	Clock's losing rate s
Jan. 25.	Moon 1 L.	6 25 12,12	
	G Gemin.	6 38 47,78	−0,27
	(281) Gem.	6 46 34,01	
	ζ Gemin.	6 52 46,73	
26.	Moon 1 L.	7 27 45,12	−0,28
	3 Cancri	7 49 47,92	
Feb. 22.	Moon 1 L.	7 4 5,46	−0,06
	f Gemin.	7 28 21,54	
	3 Cancri	7 49 44,79	
26.	48 Leonis	10 24 38,63	−0,26
	o^1 Sextant.	10 35 57,37	
	Moon 2 L.	10 52 36,54	
Mar. 23.	Moon 1 L.	8 42 56,32	+0,56
	π^2 Cancri	9 4 22,02	
	(74) Leonis	9 14 38,71	
	7 Leonis	9 25 6,59	
Mar. 27.	(77) Leon.	11 17 44,80	+0,22
	υ Leonis	11 26 47,02	
	Moon 1 L.	12 11 0,21	
Apr. 20.	Moon 1 L.	9 21 48,10	+0,44
	ψ Leonis	9 32 47,11	
21.	Moon 1 L.	10 15 1,06	+0,44
	ϱ Leonis	10 22 9,89	
May 25.	σ^2 Libræ	15 11 32,62	+0,68
	γ Libræ	15 24 0,67	
	Moon 1 L.	15 38 12,54	
June 20.	$\varkappa$ Virginis	14 1 34,54	+0,48
	Moon 1 L.	14 34 3,57	
	ξ^2 Libræ	14 45 17,92	
21.	o^1 Libræ	15 9 16,21	+0,52
	Moon 1 L.	15 22 4,02	

Date.	Name.	Clock Time of Transit. h m s	Clock's losing rate s
June 21.	η Libræ	15 32 15,53	+0,52
	θ Libræ	15 41 53,91	
22.	Moon 1 L.	16 11 14,37	+0,65
	φ Ophiuchi	16 19 8,92	
July 3.	Moon 2 L.	1 51 7,86	+0,57
	α Ceti	2 50 59,77	
24.	Moon 1 L.	20 14 28,55	
	Moon 2 L.	20 16 40,48	+0,44
	ν Capric.	20 27 48,64	
	(310) Capr.	20 37 8,28	
	19 Capr.	20 42 37,85	
25.	(240) Capr.	20 28 25,22	+0,63
	(386) Capr.	20 45 35,44	
	θ Capr.	20 53 49,33	
	Moon 2 L.	21 10 6,88	
Aug. 23.	(46) Aquar.	22 5 3,81	+0,35
	σ Aquarii	22 18 48,96	
	Moon 2 L.	22 36 31,47	
Sept. 22.	(33) Pisc.	0 6 6,55	+0,10
	t Piscium	0 13 44,17	
	(120) Pisc.	0 23 52,00	
	Moon 2 L.	0 55 41,38	
Oct. 17.	(142) Aqu.	22 22 4,31	−0,11
	64 Aquar.	22 27 14,33	
	Moon 1 L.	22 38 53,30	
	χ^3 Aquar.	23 7 2,29	
19.	(227) Pisc.	23 42 59,04	+0,38
	(270) Pisc.	23 53 15,54	
	10 Ceti	0 14 49,01	
	Moon 1 L.	0 26 53,98	
21.	(144) Pisc.	1 28 32,58	+0,20
	o Piscium	1 33 19,88	
Oct. 21.	ξ^2 Ceti	2 0 54,37	+0,20
	Moon 2 L.	2 23 2,61	
28.	Moon 2 L.	9 34 11,11	−0,22
	α Leonis	9 56 12,75	
Nov. 13.	40 Aquar.	22 1 19,38	0,00
	Moon 1 L.	22 15 8,36	
	70 Aquar.	22 36 32,04	
	K Aquar.	22 41 30,27	
15.	n Piscium	23 36 11,93	−0,36
	24 Piscium	23 41 11,28	
	Moon 1 L.	23 59 39,02	
16.	(33) Pisc.	0 6 4,12	−0,36
	t Piscium	0 13 41,88	
	Moon 1 L.	0 53 46,34	
	(57) Ceti	1 10 52,65	
19.	Moon 2 L.	3 54 6,00	−0,59
	48 Tauri	4 3 10,82	
	γ Tauri	4 7 10,77	
	ϖ Tauri	4 14 3,58	
28.	β Virginis	11 38 49,97	−0,24
	η Virginis	12 8 11,91	
	Moon 2 L.	12 45 10,43	
Dec. 10.	Moon 1 L.	21 56 15,73	+0,29
	D Aquarii	22 6 52,11	
	50 Aquarii	22 12 19,45	
	f Aquarii	22 18 9,75	
14.	(189) Pisc.	0 36 26,95	+0,09
	e Piscium	0 56 35,91	
	Moon 1 L.	1 22 2,33	
15.	ξ^1 Ceti	2 0 59,26	0,00
	Moon 1 L.	2 17 57,06	

The longitude of Cambridge Observatory is $23^s,54$ east of Greenwich.
(A positive rate is losing, and a negative rate gaining.)

V. Stars observed with the Moon, at Greenwich, in December 1831. From the Astronomer Royal.

		h m s	Daily Rate of the Clock.
December 10.	Moon 1 L.	22 0 9,88	+1″,0
	50 Aquarii	22 16 12,86	
12.	Moon 1 L.	23 41 15,68	+1 ,1
	249 Piscium.....	23 51 52,66	
18.	l^2 Tauri	4 59 18,80	+1 ,7
	(43) Tauri	5 10 46,96	
	(115) Tauri	5 17 45,23	
	Moon 1 L.	5 30 11,48	
	Clock regulated during the interval.		
19.	χ^3 Orionis	5 54 18,26	−0 ,05
	ν Geminorum . .	6 19 20,92	Cloudy.
	Moon 2 L.	6 40 35,25	

Mr. Baily announced from the chair that he had received a communication from Professor Schumacher, stating that His Majesty the King of Denmark, who enters with a lively and personal interest into every subject connected with the promotion of science, had founded a gold medal, of the value of twenty ducats, to be given to the first discoverer of a comet, not of known revolution, nor visible to the naked eye, subject to the following conditions; viz.

1. The medal is to be given to any person who may first discover a telescopic comet (that is, not visible to the naked eye,) and not of known revolution. If any doubt should arise as to what class it belongs, the decision is to be left to Professor Schumacher.

2. The discoverer must send notice to Professor Schumacher by the first post after the discovery, and fix the time of the discovery as well as he can, in order to enable Professor Schumacher to decide between several discoverers, and fix the absolute time of the first discovery, with regard to the longitude of the place, when the comet shall have been seen by more than one person on the same night.

3. This notice must contain the best possible determination of the position of the comet, and the direction of its course, if this can be ascertained from the observations of one night.

4. If the first night's observations are not sufficient to determine the direction of its course, the discoverer must, as soon as he gets a second observation, communicate it to Professor Schumacher.

5. Professor Schumacher is to decide whether a discovery is to be considered as established or not.

6. The medal is to be adjudged six months after the discovery.

7. All astronomers out of Europe may therefore enter into competition for the medal, if the above-mentioned notice come to the hands of Professor Schumacher within six months after the discovery; but, after that time, no claim can be allowed, nor any medal given.

J. Moyes, 28, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *February* 10, 1832. No. 10.

Report of the Council of the Society to the Twelfth Annual General Meeting, held this day.

IN compliance with the Bye-laws, the Council now report to the Members at large, the progress and state of the Society, at this their Twelfth Anniversary. During the past year, an important alteration in the condition of our body, alluded to in the last Report, has taken place: a Royal Charter has been obtained; and, conformably thereto, an altered and amended set of Bye-laws has been agreed to by the Society, differing however but little from those which were before in existence; the principal alterations being such as were required by this new state of things.

Amongst the subjects which necessarily engaged the attention of the Council, has been the formation of a Common Seal for executing legal documents; and the arrangement of a design and form of a Diploma, for our Associates. In the execution of this latter object, the Council have much pleasure in noticing the kind and liberal services of Mr. William Barnard Clarke, Architect, who has furnished the Society with the engraving of the head of Newton, which embellishes that public document.

The Council congratulate the Society on the favourable condition of their finances; as will appear from the following statement of their accounts for the past year, viz.

Receipts.	£.	*s.*	*d.*
Balance of last year.....	543	13	8
2 years' Dividends on £800 Consols	48	0	0
½ year's ditto on £857 13*s.* 8*d.* 4 per cents.....	17	3	0
1 year's ditto on ditto, now new 3½ per cents	30	0	4
½ year's ditto on £1065 19*s.* ditto	18	13	0
On account of Arrears ...	90	6	0
71 annual contributions, 1831–2	149	2	0
8 compositions.....	168	0	0
13 admission fees and 11 first year's contributions	49	7	0
Sale of memoirs	33	6	0
	£1147	11	0

Expenditure.	£.	*s.*	*d.*
3 gold medals	32	15	6
Priestley and Co., balance of account for printing, &c., Vol. IV. Part 1...	131	14	2
Ditto, Vol. IV. Part 2....	323	18	0
Engraving plate of Saturn, and plate for diploma	12	0	0
Purchase of £208 5*s.* 4*d.* 3½ per cent stock	189	0	0
1 year's rent of apartments to Michaelmas	52	10	0
Lights, attendance, &c., at apartments	14	7	4
1 year's salary to the assistant Secretary	100	0	0
Collector's commission on £490 1*s.* and stationery	26	16	10
Iron chest £13, and large official seal £30 10*s.*...	43	10	0
Sundry disbursements for stationery, bookbinding, &c. &c.	9	10	6
Balance in Treasurer's hands, Feb. 1832.....	211	8	8
	£1147	11	0

Assets of the Society.

				£.	s.	d.
Balance in the hands of the Treasurer				201	8	8
Arrears, Feb. 1832 :—						
2 contributions of five years' standing	£21	0	0			
5 ——— of four ditto, and 1 admission fee	44	2	0			
4 ——— of three ditto	25	4	0			
7 ——— of two ditto, and 1 admission fee	31	10	0			
11 ——— for the year just expired	23	2	0	170	2	0
1 ——— non-resident	8	8	0			
1 contribution at 4 guineas } for New Fellows	4	4	0			
4 ——— at 3 ditto }	12	12	0			
Some other amounts, doubtful.						
£1865 19*s.* stock, valued at				1690	0	0
Due by Messrs. Priestley and Weale for Memoirs sold				56	4	6
Unsold Memoirs.						
Various astronomical instruments, books, prints, &c.						
1 gold medal unappropriated.						
15 silver ditto.						

Abstract of the present state of the Society, as regards its Fellows :—

	Compounded.	Annual Contributors.	Non-resident.	Honorary and Patron.	Total Members	Associates.	Grand Total.
Feb. 1831 ...	45	101	110	2	258	41	299
Since elected	8	10	...	...	18	3	21
Since lost ...	...	1	4	...	5	2	7
Feb. 1832 ...	53	110	106	2	271	42	313

The instruments belonging to the Society are now in the possession of the following gentlemen:

Beaufoy Circle and Clock,	Rev. M. Ward.
Wollaston Telescope and Micrometer,	Mr. Maclear.
Lee Circle,	Capt. Smyth.
Transit and Clock, returned by Capt. Smyth,	Mr. T. Jones (for safe custody).
Two pendulums lent to Capt. Foster,	Mr. Baily.

The Council refer the Society with pleasure to the numerous observations of occultations and eclipses of Jupiter's satellites, communicated by Mr. Maclear, and read in December last.

A well-arranged and accurate catalogue of the Library has been formed by Mr. Epps, the Assistant-Secretary, and the books are now being compared with this catalogue by a Committee appointed for the purpose, which has nearly finished its labours.

Amongst the deaths which have occurred in the preceding year, the Council regret the loss of two very valuable members of the Society, as well as two of its Associates: viz. the Rev. Fearon

Fallows, late astronomer at the Cape of Good Hope, Capt. Foster of the Royal Navy, M. Pons of Marlia, and the Abbé Grégoire.

Mr. Fallows is an example, and, in this country, happily, not a solitary example, of the influence which talents and character may have on the fortunes of an individual, under circumstances apparently the most untoward. He was born, July 4, 1789, at Cockermouth, in the county of Cumberland, and his early years were spent in following his father's occupation, that of a weaver, with no further time or opportunity for education than could be afforded by the ordinary intervals of labour. Fortunately, his father was himself a man of considerable information and studious habits, and devoted these leisure moments to the education of his child, who thus became early acquainted with the principles of arithmetic and geometry, subjects in which he chiefly delighted. When a mere boy, a mathematical book was his constant companion at the loom; and this taste was encouraged by the kindness of many persons in the vicinity, who supplied him with books, and such assistance in his studies as they were competent to give. His father having become parish clerk at the neighbouring church of Bridekirk, the extraordinary acquirements of the young mathematician became known to the Rev. Mr. Hervey, vicar of that parish; and by the advice and recommendation of this gentleman, Mr. Fallows was engaged as an assistant by Mr. Temple, at that time head-master of Plumbland school. On the death of Mr. Temple in 1808, Mr. Hervey further exerted himself to obtain for Mr. Fallows the patronage of some gentlemen of fortune and interest, in order that he might be enabled to go to the university. In this purpose he was successful; and in 1809, Mr. Fallows commenced residence as a student of St. John's College, Cambridge.

Whatever difficulties might have previously embarrassed Mr. Fallows' career were now dissipated. At St. John's, honourably distinguished (perhaps above all other colleges) for attention to the education and interests of unfriended merit, he found every assistance which could be desired,—kind friends, most able instructors, and an unlimited power of consulting books. His progress was, accordingly, rapid and successful, though directed, as was to be expected, in the line of the older English geometers, with whom he was already familiar, rather than according to the continental mathematicians. In 1813, he proceeded bachelor of arts, and was third, Sir John Herschel being senior wrangler.

Shortly after taking his degree, as there was no fellowship open at St. John's to which Mr. Fallows was eligible, he removed to Benet College, as mathematical lecturer; but was gladly recalled to his own college in 1815, when a fellowship became vacant. Here he resided for some years; and when his Majesty's Government had resolved upon establishing an Observatory of the highest class at the Cape of Good Hope, Mr. Fallows was selected as the person best qualified to direct the future establishment.

The few months which intervened between the time of his ap-

pointment and his removal to the Cape, were spent by Mr. Fallows in the public and private observatories of this country, in the workshops of our most celebrated artists, in the calculation of special tables, and in devising the best and simplest means of making, registering, and reducing astronomical observations.

On the 1st Jan. 1821, he married Miss Mary Anne Hervey, eldest daughter of the Rev. H. A. Hervey, vicar of Bridekirk, and embarked on the 4th of May following. Mr. Fallows arrived at the Cape on the 12th of August, 1821.

His first undertaking was an approximate catalogue of 275 principal stars, published in the *Phil. Trans.* 1824. From the description of the instruments employed, it will be seen that they were of a very humble description, viz., a portable transit of only twenty inches focal length, and a very indifferent altitude and azimuth instrument by Ramsden, ill-divided, and unstable in its adjustments, being indeed originally constructed as an equatorial. It is probable that the length of time which must necessarily elapse between the design and completion of a first-rate Observatory, in a foreign station, was not fully taken into account, either by the Government or the astronomer; otherwise the temporary instruments would, doubtless, have been of a very different class. The plan of the Observatory was received by Mr. Fallows in the latter part of 1825, and he immediately proceeded to carry it into effect. A site was selected about three miles from Cape Town, and Mr. Fallows lived in a tent on the spot, to determine the lines of the building, and to superintend the workmen. The foundations were dug out before the clerk of the works arrived to relieve him from this task.

In the beginning of 1829, the transit and mural circle were fixed in their places, and we might now have anticipated a season of enjoyment for the Cape astronomer; but, for some cause hitherto unexplained, the circle, to which he had looked forward with pride and exultation, proved for a long time a source of bitter uneasiness. Some part of this must, doubtless, be attributed to the shattered state of the observer's health; but the fact, that "the index "error of two opposite microscopes was ever variable in different "parts of the instrument, while with three microscopes, at 120° dis- "tance from each other, or with the whole six, the index error was "nearly constant," was sufficiently startling to harass a person of less sanguine and zealous temper. Finally, Mr. Fallows was of opinion that some permanent injury had been received by the circle and axis, from a fall which the package received whilst it was removing from the hold of the ship at the time of landing; but that the mean of the six microscopes might be fully depended upon; since high and low stars, when observed directly and by reflexion, gave the same position of the horizontal point. Before he had come to this conclusion, which seems to have been some time in the middle of 1830, sickness deprived him of the services of his assistant, Capt. Ronald; and Mr. Fallows was left, unaided, to do the best he might with a transit and mural

circle. He was relieved from this difficulty by the affection and intelligence of Mrs. Fallows, who offered to undertake the circle observations while he was engaged with the transit. A very little instruction sufficed to render her perfectly competent for this task; and the Cape astronomer had, like Hevelius, the pleasure of finding his best assistant in the partner of his affections. Some of his letters, written at this time, express a strong hope and confidence that he should at length be able to justify the high expectations which had been formed of the Observatory, and that his work would bear a comparison in accuracy, though not in extent, with that of any other establishment.

But the labours of the Observatory were too much for a constitution already much enfeebled by previous illness. He had suffered very severely from a *coup de soleil* soon after his arrival at the Cape, while fixing the small transit; and, besides some less serious complaints, experienced a dangerous attack of scarlet fever in the summer of 1830, from which he seems never to have fully recovered. In the beginning of 1831, his health was visibly impaired, but he could not be induced to leave the Observatory before the equinox. Towards the end of March, he became incapable of struggling any longer with the disease, and went to Simon's Town; but it was now too late, and he breathed his last on the 25th July, 1831, in the forty-third year of his age.

To those who were acquainted with Mr. Fallows, it is unnecessary to dwell upon the integrity and simplicity of his character, or the depth and clearness of his understanding: as an astronomer, he had few rivals. Perfectly acquainted with the practical and scientific departments of astronomy, he carried into the Observatory the same straightforward zeal and honesty which were the distinctive features of his private character; and if his life had been spared, would unquestionably have realised the most sanguine expectations of his friends and admirers.

Mr. Fallows did not leave his observations completely prepared for publication, but so nearly as to require very little additional labour. His wish was to have had them printed under his own eye, after they had been examined and approved of by competent judges in England; for which purpose, examined copies were transmitted by him to the Lords Commissioners of the Admiralty. They consist of about 3000 transit, and several hundred circle observations, with six microscopes, and some series with the invariable pendulum. The instrumental errors are ascertained, and the current reductions computed, so that there will be no difficulty in presenting the results, though not perhaps in the independent manner proposed by the observer. It is to be hoped that these observations and reductions will be speedily published, by the order of the founders and patrons of the Cape Observatory; and we are confident, that they will be found every way worthy of Mr. Fallows and of the country which committed that important and magnificent establishment to his charge.

But though the loss inflicted upon science is thus severe, your

Council are happy to state, that the Government has not at all relaxed its zeal for the Cape Observatory. An assistant, Mr. Meadows, was despatched to aid Mr. Fallows, shortly before his decease: since that time, Mr. Thomas Henderson (a gentleman known to you all, as one of the most active and enlightened cultivators of astronomy in this country, and one to whom this Society has, upon many occasions, thankfully acknowledged its obligations) has been appointed his Majesty's Astronomer at the Cape. That this gentleman, treading in his predecessor's path, and with better health, and under better auspices, may reap the rich harvest which Mr. Fallows could only commence, is the confident wish and hope of those by whom his merit, zeal, and modesty, are appreciated.

Capt. Foster was well known to every scientific man in this country, for his active services in the expedition under Capt. Parry to the North Pole, and for his ardent zeal and great attention to accuracy in every thing which he undertook for the promotion of science. These and other excellent qualities which he possessed, led to his more immediate promotion in the Navy, gained him the reward of the Copley Medal from the Royal Society, and pointed him out as a fit and proper person to conduct a scientific expedition, at that time contemplated by the Government, towards the South; and he was soon after appointed to the command of the *Chanticleer* for that purpose.

The principal object of this expedition was to swing the pendulum near the equator, and also at various places in the southern hemisphere. With this view he was furnished by Government with two of Kater's invariable pendulums, No. 10 and No. 11; and also by this Society with two convertible pendulums of a new construction, one of Iron and the other of Copper, as described in No. 13 of the Monthly Notices, and alluded to in the Eighth Report. Capt. Foster however did not live to bring home the fruits of his own industry and zeal; for he was unfortunately drowned, near the close of his voyage, whilst descending the river *Chagres* in a canoe, towards his ship then lying at anchor.

Capt. Foster has left behind him a vast mass of important information connected with the objects of his voyage. The original copies of his pendulum experiments have been laid before the Council of this Society by the Lords Commissioners of the Admiralty, with a request that they would consider the best mode of obtaining the proper results, with a view to their being made public in the most satisfactory manner. For the attainment of this object Mr. Baily has kindly undertaken to superintend the computations, and to make such further experiments on the pendulums in London, as may be necessary to deduce the required results from the whole series of Capt. Foster's experiments. Already these supplementary experiments are completed; and the computer has also made great progress in reducing the observations from the elements furnished by Mr. Baily for that purpose: and when the whole is finished, a Report will be drawn up on the subject.

Capt. Foster's journal of his experiments is a model of his great

attention to accuracy and minuteness of detail. Every necessary information is regularly entered in *printed blank forms*, with which he had been previously provided (a method which cannot be too strongly recommended in all similar cases); and there is consequently no difficulty or doubt as to the full meaning and effect of every figure that is introduced. The number of places at which Capt. Foster swung the pendulum (including London and Greenwich) is fourteen; and subjoined is a list of these places, in the order in which they were visited, together with the number of series of experiments made at each place, and the pendulums employed at each station. It should here be, however, stated that the iron and copper convertible pendulums were each furnished with *two* knife-edges (respectively marked A and B); so that, in fact, Capt. Foster might be considered as having *six* independent and invariable pendulums, whose results might be compared with each other. The stations that are marked with an asterisk are those which were visited also by Capt. Sabine, in his voyage of experiment in the years 1822 and 1823.

No.	Stations.	No. 10.	No. 11.	Iron.		Copper.	
				A	B	A	B
1	London	8	7				
2	Greenwich	10	10				
3	Monte Video	25	15				
4	Staten Island	46	26	11	12	16	16
5	South Shetland	23	62	15	16	9	10
6	Cape Horn	22	27				
7	Cape of Good Hope	25	17	28	28	23	23
8	St. Helena	21	24			9	12
9	Ascension Island .....*	39	26	10	9	14	13
10	Fernando de Noronah	21	18				
11	Maranham .....*	19	16			16	12
12	Para.....	18	22	12	13	14	14
13	Trinidad .....*	20	17	9	9	12	12
14	Porto Bello.....	21	15				
	Total number of series	318	302	85	87	113	112

The whole number of series therefore was 1017; and as each series consisted (on an average) of 10 coincidences, the total number of coincidences taken by Capt. Foster was upwards of ten thousand: thus forming a mass of observations made in various parts of the globe never before attempted by any individual, and which must have its due weight in all investigations relative to this

important inquiry. In the premature death of this young and accomplished officer, the Society has to deplore the loss of a zealous and active votary to science; and his memory will be long held dear by those who were more intimately acquainted with him in the relations of private life.

M. Jean Louis Pons was for many years employed at the Observatory at Marseilles; where, though his means were extremely limited, he became universally known for his steady attention to the discovery of comets: an attention which procured him the Medal of this Society. In the summer of 1819, Her Majesty Maria Louisa, of Bourbon, entered into a correspondence with Baron de Zach respecting the endowment of a first-rate Observatory at Lucca; desiring him to solicit an astronomer of known eminence to preside. Three names were immediately suggested; Encke, Littrow, and Pons: and as the two former had received appointments in their own countries, the choice fell on the latter. In the mean time the Baron had repaired to Lucca, in order to select the site and direct the erection of the required edifice. It was 100 feet long, by 30 in breadth, independent of dwelling apartments; and was built on a hill in the royal park of La Marlia, four miles from the city, with an excellent command of horizon; and was munificently furnished with instruments of the best description. M. Pons was honoured with the titles of "Her Majesty's Astro-"nomer Royal, Director of the *Astroscopic* department of the "Observatory, and Emerito Professor of the Royal Lyceum." Amongst other arrangements was the payment of 100 dollars, from the queen's purse, for every comet that might be discovered: and it is remarkable that M. Pons, immediately on his arrival, detected the one forming an isosceles triangle with γ and μ *Virginis*. From such a commencement, the astronomical world had great reason to form high expectations; especially as it was decided that the Observations should be published annually, after the manner of those at Greenwich. But, the energy of the institution was spent in its mere erection: it promised much, but performed nothing: and after lingering in existence about four years, it was at length formally abolished. M. Pons, after this disappointment, continued to observe with such means as he could obtain; till Leopold II. invited him to Florence, on conditions as honourable as magnificent. He accordingly went thither in July 1825, after having just recognised Encke's comet at Lucca, before his departure. The previous computation of its return had been a guide to his researches; yet it proved the excellence of his eye at the age of 64, as he saw it long before any one else.

The Abbé Grégoire, afterwards Bishop of Blois, is known to us principally as having taken an active part in the establishment of the Board of Longitude in France, in imitation of the English board, to which was to be confided the publication of the *Connaissance des Tems*. The Abbé, in common with many of his scientific countrymen, was not insensible to the great advantages to be derived, in a maritime point of view, from a well-conducted

Nautical Almanac: and one of the avowed objects for establishing the board in question, was the prospect that the French might be better enabled to compete with this country, with whom they were then at war.

During the past year, the Lords Commissioners of the Admiralty have consulted the Council also on another important subject, connected with the advancement of navigation. In consequence of the alterations about to be introduced into the *New* Nautical Almanac, it has been considered expedient that new *Requisite Tables* should be formed to accompany it: and, with the view of carrying this object into effect, in the most efficient and satisfactory manner, a Committee has been formed to consider, arrange, and propose such Tables as may be thought most proper for that end. This Committee has already met, and a sketch of the proposed Tables has been drawn up, but not yet agreed upon: for, in an affair of so much importance, there cannot be too much time devoted to the consideration of the subject.

It has been a constant source of regret to the Council, as well as to the Members at large, that they have not yet been able to meet with a suite of apartments, where they might consider themselves as permanently fixed. They are fully aware that the interests of the Society are suffering much from this circumstance: but, notwithstanding all their endeavours (and they have been incessant) they have been unable to remedy the defect in a manner agreeably to their wishes. His Royal Highness the Duke of Sussex, having been informed of this circumstance, was pleased to express a desire to exert himself in endeavouring to obtain apartments at Somerset House, contiguous to those of the Royal Society: and, in consequence of this obliging offer, a deputation was appointed to wait on His Royal Highness, to thank him for his kind intentions, and to represent to him the inconveniences of our present situation. His Royal Highness then repeated his best wishes for the success of the Society, and promised to use his endeavours to obtain the apartments in question. The Council, however, have not yet been informed of the result of His Royal Highness's application.

The Standard scale, mentioned in the last Report, is not yet executed. The work has remained a long time stationary, waiting for the micrometer object glasses promised by Mr. Tulley: but which, up to the present time, he has not been able to complete.

Several of the early numbers of the *Monthly Notices* of the proceedings of this Society, having been out of print, and much in request, the Council have made arrangements with the publishers for a reprint of the first fourteen numbers, at a trifling expense: so that those Members whose sets may be deficient in any of such numbers, may now be supplied with new copies to complete them.

No subject having been specifically brought before the Council, as deserving of the Society's medal, on the day appointed by the bye-laws for awarding the same, it has not been adjudged this year.

The Second Part of the Fourth Volume of the Memoirs of the

Society has been some months before the public: and the Members will see, from the numerous articles it contains, the increased activity and interest taken in the science.

Your excellent Treasurer, Dr. Lee, desirous of adding to the importance and interests of the Society, has liberally offered to present the vicarage of Stone in Buckinghamshire to such person as the Council might nominate. They accordingly proposed the Rev. Mr. Fisher, a gentleman well known for his scientific attainments, and for his amiable character in private life. But as it did not suit Mr. Fisher's arrangements to resign the station which he at present fills, the Council next proposed the Rev. Mr. Fletcher, another Member of this Society; who has since been appointed to the vacant living.

His Majesty the King of Denmark, who personally and zealously enters into every subject that may tend to the promotion of science, has recently founded a medal for the discovery of any telescopic comet; subject to the following conditions: viz.

1. The medal is to be given to any person who may first discover a telescopic comet (that is, not visible to the naked eye,) and not of known revolution. If any doubt should arise as to what class it belongs, the decision is to be left to Professor Schumacher.

2. The discoverer must send notice to Professor Schumacher by the first post after the discovery, and fix the time of the discovery as well as he can, in order to enable Professor Schumacher to decide between several discoverers, and fix the absolute time of the first discovery, with regard to the longitude of the place, when the comet shall have been seen by more than one person on the same night.

3. This notice must contain the best possible determination of the position of the comet, and the direction of its course, if this can be ascertained from the observations of one night.

4. If the first night's observations are not sufficient to determine the direction of its course, the discoverer must, as soon as he gets a second observation, communicate it to Professor Schumacher.

5. Professor Schumacher is to decide whether a discovery is to be considered as established or not.

6. The medal is to be adjudged six months after the discovery.

7. All astronomers out of Europe may therefore enter into competition for the medal, if the above-mentioned notice come to the hands of Professor Schumacher within six months after the discovery; but, after that time, no claim can be allowed, nor any medal given.

Amongst the numerous works presented to the Society during the past year, the Council notice with much gratification, the Miscellaneous Works of Dr. Bradley, by the University of Oxford, edited under the able superintendence of Professor Rigaud: containing what has long been considered a desideratum in the history of Astronomy, the original observations made at Kew and at Wanstead, with the zenith sector, and the progress of his celebrated discoveries of aberration and nutation. The principal part of these

valuable documents were discovered by the active and diligent search of Professor Rigaud, amongst the papers of the late Dr. Hornsby, whose family readily gave them up to the University for publication; the rest have been collected from various sources: and the volume altogether reflects great credit on the University of Oxford, and adds new lustre to the character of the distinguished astronomer whose labours it records.

The Council are happy to announce that the plan for making a minute survey of the heavens, and for the formation of some new celestial charts, under the superintendence and direction of the Royal Academy of Sciences at Berlin, appears to have been carried into full effect; and three portions of this useful and valuable undertaking now lie on the table: viz. the 10th hour in $\mathcal{R}$ by Professor Göbel of Coburg, the 14th hour by the Rev. T. J. Hussey of Chislehurst, and the 18th hour (in duplicate) by Padre Giovanni Inghirami of Florence, and M. Capocci of Naples. The respective catalogues contain a list of all the stars (reduced to the year 1800) within 15° of the equator, which are to be found in Bradley, Piazzi, Lalande's *Histoire Céleste*, and Bessel's *Zones*: whilst the charts contain, besides these stars, such other additional ones as may have been seen by the respective observers, down to the 10th magnitude exclusive. This work, when complete, will form the most extensive and accurate general catalogue of the stars that ever was produced: and will be a valuable acquisition to the practical astronomer.

To P. Inghirami the public are also indebted for another recent production, executed on the true principles of science, under the patronage of the Grand Duke Leopold II. This consists of a laborious and detailed survey of Tuscany, deduced from a base of 4488·08 toises, measured with the most rigid precaution between Pisa and Leghorn in the autumn of 1817. Besides giving an excellent series of determined latitudes and longitudes, in the course of leading his chain of triangles from the valley of the Arno to the mountains of the interior, P. Inghirami has entered into an investigation of some delicate corrections, arising from what he terms "lateral refraction;" of which an interesting memoir was communicated to the *Academica Labronicâ* in 1818. One great advantage attending this valuable work is the prompt and speedy manner in which it has been published; whereby the present generation, which has contributed to its production, will reap the benefit and information contained in this national undertaking: a consideration too often neglected.

The year which has just expired has also been marked by the production of a work now on the table, too remarkable to escape our notice, whether we consider what it contains, or by whom it was written. We allude to the "Mechanism of the Heavens" by Mrs. Somerville. This lady has added to our stock the most complete account of the discoveries of continental mathematicians in physical astronomy which exists in our language. Following closely in the steps of Laplace, but diverging to take notice of the discoveries of

Lagrange, Poisson, and others, she has produced a treatise, which, while it paves the way to a complete understanding of the *Mécanique Céleste*, may be substituted for it by all who do not require, we will not say the most profound, but the most widely-extended knowledge of the heavenly phenomena. Commencing with a general exposition of the laws of mechanics, as in the *Mécanique Céleste*, the authoress proceeds to the proofs of the general theory of gravitation, the elliptic motions of the planets, their perturbations and secular inequalities; generally, though not universally, adopting the methods of Laplace. She then considers the lunar theory, and that of the satellites of Jupiter. At the end of each part the numerical values of the perturbations are deduced; and any particular cause, which might produce a perturbing effect, such as the resistance of a medium, or the attraction of the fixed stars, is inquired into. In a preliminary dissertation a popular account of the results is given, the whole thus forming a complete system of physical astronomy. In concluding this slight notice, your Council cannot forbear their expression of delight and admiration at the achievement of our countrywoman; or of hope, that the example thus set may stimulate others to exertion in a field which, they lament to say, has been too much neglected in England.

The vacancy occasioned by the death of Mr. Fallows, has been supplied, as already noticed, by the appointment of Mr. Henderson: and the Council cannot omit this opportunity of again* bringing before the Society the very able assistance which has been, from time to time, afforded them by the voluntary labours of this gentleman. Bound to the Society by no conventional engagement (for, Mr. Henderson has but very recently become a Fellow of the Society), he was always ready to aid and assist in any investigations that might be required. And although the Council cannot but lament, in common with the Society, the partial separation of so active a member, yet they are well aware that the powerful resources of his mind will be more efficiently called into action, and will reflect more honour on his name and nation in the new sphere in which he is about to engage.

Previous to his departure for the Cape, Mr. Henderson made arrangements for observing Mars at his opposition in November next: and requested Mr. Baily to select the stars proper to be observed with that planet. This has been done; and the Council have directed that the same shall be printed and circulated amongst different observers, in order that the greatest advantage may be taken of the favourable opportunities now afforded for determining the parallax of that planet. Arrangements had been previously made with Mr. Fallows for observing the parallax of the moon; and the stars proper for that purpose are now distinguished by an asterisk in the annual list of the moon-culminating stars: and as, in all probability, a proper selection of stars will be made and pub-

* At the anniversary in 1830, the Society presented Mr. Henderson with a copy of its Memoirs, as a small token of their sense of his services.

lished in future, for the subsequent oppositions of Mars, and the inferior conjunctions of Venus, there is now every reason to hope that, with the co-operation of active astronomers, the parallaxes of these respective bodies will soon be determined with the greatest accuracy.

Besides the Observatory at the Cape of Good Hope, and the Observatories of Paramatta and Madras, we have also, in the southern hemisphere, another at the island of St. Helena, founded by the East India Company, and placed under the superintendence of Mr. Johnson. Captain Lloyd also, who has been lately appointed Surveyor-General to the island of Mauritius, has taken out some excellent instruments to that island; and a 3½-feet transit instrument, by Troughton and Simms, is about to be forwarded to the same place, at the expense of Government, to be placed under the superintendence of M. Dabadie, whose observations on the comet of 1830 were communicated to this Society. And Captain King, R.N., is also shortly about to sail for New South Wales, provided with some astronomical instruments for his own private use. Thus, in the southern hemisphere, where a few years ago we could scarcely reckon a single observer, we have now several active and zealous persons, employed in watching the motions of the heavenly bodies; and in making such observations as may tend to advance the connected sciences of astronomy, navigation, and geography. And here the Council cannot avoid suggesting to those observers, the great advantage that may be taken of their fortunate positions, by their forming arrangements with Mr. Henderson for making such observations, either of moon-culminating stars or such other celestial phenomena to be agreed on, as may tend to fix, on a firm and durable basis, the true longitudes of their respective stations: which will thus become so many zero points on the globe to which the navigator and the geographer may in all cases confidently refer.

Titles of the Papers read before the Society, between February 1831 *and February* 1832.

March 11, 1831. A Letter from Mr. Rumker to Sir J. South, on the appearances of Stars on the Moon's Disc.

A Paper on Irradiation. By Dr. Robinson.

April 8. Extract of a Letter, dated March 24, 1831, from M. Cauchoix, of Paris, to the Rev. R. Sheepshanks, concerning a large Object Glass of 13·29 inches aperture, which had just been finished by M. Cauchoix.

A Paper from Mr. Pond, the Astronomer Royal, containing the results of all the Observations made at Greenwich of the Sun's Zenith Distances, at or near the Solstices, from the time of Bradley to the present.

A Paper from Sir T. Brisbane, containing Observations of the Moon and Moon-culminating Stars, made at Makerstown, in 1829 and 1830.

On the Theory of the Eye-Glasses of Telescopes. By Professor Littrow.

May 18. A Paper by Mr. Baily, on Lacaille's Catalogue of 398 principal Stars.

A Letter from Mr. Dawes, dated April 13, 1831, concerning the triple Star ξ Cancri.

An Index to the Society's Catalogue. By Mr. Stratford.

A Paper containing Micrometrical Measurements of the Angles of Position and Distances of 364 Double Stars. By Sir J. Herschel.

June 10. Observed Occultations of Jupiter and his Satellites by the Moon, on June 1, 1831. By the Astronomer Royal, by Mr. Snow, and by Captain Smyth.

A Letter from Mr. Dawes to Sir J. Herschel, containing Observations of several Double Stars, made during the last and present year.

A Paper by the Rev. Dr. Robinson, on the Dependence of a Clock's Rate on the Height of the Barometer.

Nov. 11. Observed Occultations and Eclipses of Jupiter's Satellites. By Mr. Maclear, made with the Society's Wollaston Telescope, from May 1830 to the present month.

Three observed Occultations in May and June last, and Five observed Eclipses of Jupiter's Satellites, in the months of August, October, and November. By Mr. Snow.

Observation of the Occultation of Aldebaran on the 23d of October. By Mr. Holehouse.

Observations of the Right Ascensions and Polar Distances of the Planets Uranus, Jupiter, Vesta, and Mars, from September to December 1830. By M. Bianchi.

Extract of a Letter, dated October 1831, from M. Cauchoix to Mr. Lubbock, announcing the completion of

another large Object Glass, of the same dimensions as that which Sir J. South is now mounting.

A Catalogue of the Stars observed with the Moon from June to October 1831, at the Greenwich Observatory. From the Astronomer Royal.

A Paper on the Orbits of Binary Stars. By Sir J. Herschel.

Dec. 9. A Paper by Mr. Baily, on the proper motion of the Fixed Stars.

A List of Stars observed with the Moon from the 13th to the 26th November last. From the Astronomer Royal.

Jan. 13, 1832. A List of Occultations, and of Stars observed with the Moon in 1831. By Professor Airy.

Observations of Occultations during the year 1831. By Captain Smyth.

A Letter from Sir J. South to Mr. Baily, on the Occultations of 119 and 120 Tauri, on the 18th December, 1831.

A List of Stars observed with the Moon at the Greenwich Observatory, in December 1831. From the Astronomer Royal.

A List of Public Institutions, and of Persons, who have contributed to the Society's Library, &c., since the last Anniversary.

Royal Society.
Royal Academy of Berlin.
Royal Academy of Brussels.
Cambridge Philosophical Society.
Royal Society of Edinburgh.
Geological Society.
Royal Institution.
L'Académie Royale des Sciences de l'Institut de France.
Le Bureau des Longitudes.
Society of Arts.
Zoological Society.
Athenæum.
Clockmakers' Company.

Professor Airy.
Charles Babbage, Esq.
T. S. Davies, Esq.
A. De Morgan, Esq.
G. Dollond, Esq.
J. E. Drinkwater, Esq.
J. Dryden, Esq.
Professor Encke.
Professor Hamilton.
Professor Hartmann.
Rowland Hill, Esq.
James Holland, Esq.
M. Maurice.
F. Page, Esq.
Professor Quetelet.
Edw. Riddle, Esq.
Professor Rigaud.
Dr. Robinson.
Professor Schumacher.
Mrs. Somerville.
Lieut. Stratford.
Richard Taylor, Esq.
Capt. Woodley.

The Meeting then proceeded to the Election of the Council for the ensuing Year, when the following Fellows were elected, viz.

President: John Brinkley, D.D. *Lord Bishop of Cloyne.*—*Vice-Presidents:* Francis Baily, Esq. F.R.S. L.S. and G.S. and M.R.I.A.; Davies Gilbert, Esq. M.P. V.P.R.S. F.L.S. & G.S.; John William Lubbock, Esq. M.A. V.P. & *Treas.* R.S.; Rev. William Pearson, LL.D. & F.R.S.—*Treasurer:* John Lee, Esq. LL.D.—*Secretaries:* Augustus De Morgan, Esq.; John Wrottesley, Esq. M.A.—*Foreign Secretary:* Captain W. H. Smyth, R.N. F.R.S. & A.S.—*Council:* George Biddell Airy, Esq. M.A. *Plumian Prof. Ast. University of Cambridge;* Charles Babbage, Esq. M.A. F.R.S. *Lucasian Prof. Math. University of Cambridge;* Captain F. Beaufort, R.N. F.R.S.; Lieutenant Thomas Drummond, R. E.; Captain W. F. W. Owen, R.N.; Lieut. Henry Raper, R.N.; Edward Riddle, Esq.; Rev. Richard Sheepshanks, M.A.; Lieutenant William S. Stratford, R.N.; Edward Troughton, Esq. F.R.S. L. & E.

J. Moyes, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

Vol. II. *March* 9, 1832. No. 11.

THE following communications were read:—

I. A Letter from Mr. Snow to the Secretary, dated Jan. 2, 1832:

"I have the pleasure to say that I observed the late occultations of 119 and 120 *Tauri*, and of *Regulus*.

"119 *Tauri* before its occultation was gradually approaching the moon's dark limb, but it did not disappear until it reached the bright part of the moon, and vanished quite instantaneously upon touching the summit of a long, irregular, lunar mountain, without suffering the smallest alteration in colour or light before its disappearance.

"120 *Tauri* was not quite so certainly observed, as it disappeared just *before* it reached the bright part of the moon, which I was in hopes it would not have done. At the time the occultation of 119 *Tauri* took place, the moon wanted about 5^h of coming to the meridian, and was so nearly full when on the meridian, that both limbs were observed over the wires of the transit-instrument, and gave a semi-diameter agreeing very nearly with that set down in the *Nautical Almanack*: the moon's R.A. thus determined was $5^h\ 31^m\ 3^s,54$. However, when the occultation took place, the quantity that the moon wanted of being full was too small to be estimated by the eye." (Telescope 42 inch refractor; power 120.)

This letter was accompanied by a printed extract from the *Bibliothèque Universelle of July* 1831, containing Baron Zach's observation of the immersions and emersions of *Jupiter's* satellites on June 1, 1831; and also a notice of an astronomical board established in China, which appears to be the same as the well-known *Tribunal of Mathematics*. The number of members at present is seven, of whom three are Europeans.

II. Observations of the comets of 1830 and 1831, by different observers; also, various computations of the elements of the said comets. Collected by Baron Zach, and communicated by Mr. Snow.

These observations, which were made in April and May 1830, and from January to March 1831, consist of right ascensions and declinations, and come from the observatory at Greenwich, Sir James South at Kensington, MM. Gambart at Marseilles, Wartmann at Geneva, Gautier at Chougny, Valz at Nismes, Encke at Berlin, and Rumker at Hamburg. The elements are by MM. Rumker, Valz, and Peters of Copenhagen.

III. Emersion of *Aldebaran* on Feb. 10, 1832, by the Rev. M. Ward. N. latitude 52° 43′ 45″ 18. W. longitude 8^{m} 46^{s},8.

	h	m	s
Instantaneous emersion of Aldebaran	2	57	28,9
Aldebaran transited mid. wire of circle	4	26	13,3
West limb of ☽ ditto ditto	4	28	51,3
Daily gain of the clock.....			1,63

IV. Stars observed with the Moon at Blackheath, from August 1831 to January 1832, by Mr. Wrottesley. The observations were made with a five foot transit.

V. Observations made at the East India Company's Observatory at St. Helena, by Mr. Johnson.

These consist, first, of observations of the moon and moon-culminating stars from January to August 1830; secondly, of observations of the solstices of December 1829, and of June and December 1830. The latitude of the observatory deduced from them is 15° 55′ 23″,65, while from several of the Greenwich stars, observed alternately by direct vision and reflexion, it is 15° 55′ 26″,54.

VI. On the Planetary Theory, by Mr. Lubbock.

The object of this paper is to point out some simplifications which may be obtained in developing the functions R and $r\left(\frac{dR}{dr}\right)$ by the use of the binomial theorem. Mr. Lubbock applies this method to the determination of that part of $r\left(\frac{dR}{dr}\right)$ which contains the first powers only of the eccentricities.

VII. On the Rotation of *Venus*, by the Rev. Mr. Hussey.

Mr. Hussey's object in this paper is to shew that the time of rotation of *Venus* asserted by Bianchini, of 23 days and 8 hours, is a near approximation to the truth, in opposition to Cassini and Schroeter, who fixed the same, the former at 23^{h} 15^{m}, the latter at 23^{h} 21^{m}; and to Sir W. Herschel, who, though he declares the time of rotation to be doubtful, thinks it cannot be so much as 24 days. The observations of Bianchini are quoted at length, in his own words, by Mr. Hussey, who also enters minutely into the arguments used by the younger Cassini, in support of his father's observations. From a review of the whole argument, Mr. Hussey concludes from Cassini, Maraldi, and Herschel, not having been able with powerful instruments to distinguish the spots of *Venus*, that their latitudes were unfavourable for such observations; that the observations of Schroeter are not to be depended upon, as Sir W. Herschel was unable to verify the same, with a more powerful telescope; that Cassini's observations are in the same predicament, having been made with an inferior instrument, imperfectly mounted and without a micrometer, and not having been much relied on by the observer himself; that we are justified in placing confidence in the observations of Bianchini, from the favourable circumstances under which they were made, the minuteness with which they are

detailed, from their correctness having been ascertained by several bystanders, from the superior nature of the instruments employed, from the measurements being micrometrical, and from the character of the observer. Annexed to this paper were several diagrams of the spots of *Venus*.

VIII. Observations on the Magnitudes of Stars. By Mr. Birt; communicated by Mr. Lubbock.

These observations were made between April 1830 and January 1831. In the notes subjoined to them, the author has pointed out various discrepancies between the magnitudes assigned to the same star by different observers, from all of which, in some cases, his own determination differs. The principal instances are *Pollux*, γ and α *Cassiopeæ*, α, ι, and ζ *Cephei*, $\varkappa$ and ι *Ophiuchi*, β and ε *Aquilæ*, and $\varkappa$ and λ *Lyræ*.

IX. Stars observed with the Moon, at the Royal Observatory, Greenwich, in January and February 1832.

		h m s	Daily Rate of Transit Clock.
January 11.	μ Piscium	1 21 4,62	
	ν Piscium	1 32 22,70	+0″,03
	☽ 1 L.	1 57 2,58	
	ξ^2 Ceti	2 18 55,28	
14.	☽ 1 L.	4 54 8,28	
	115 Tauri	5 17 4,54	+0″,02
	119 Tauri	5 22 4,18	
15.	119 Tauri	5 22 4,06	
	☽ 1 L.	6 0 0,00	−0″,02
	ν Geminorum	6 18 41,24	
25.	β Libræ	15 7 38,34	
	☽ 2 L.	15 28 45,36	−0″,23
	β^1 Scorpii	15 55 20,24	
	(4) Ceti	3 2 48,04	
February 9.	ξ Tauri	3 18 43,50	+0″,04
	☽ 1 L.	3 30 12,84	
	48 Tauri	4 6 53,93	
14.	θ Cancri	8 22 41,44	
	☽ 1 L.	8 45 54,14	+0″,10
	π^2 Cancri	9 6 37,38	

X. Occultations and Stars observed with the Moon, at the Observatory, Cambridge, in January and February, 1832.

Day.	Name.	Time of Transit. h m s	Clock's losing rate. s
January 11.	μ Piscium	1 21 11,02	1,02
	ν Piscium	1 32 29,40	
	Moon 1 L.	1 57 8,58	
	ξ^2 Ceti	2 19 2,14	
14.	Moon 1 L.	4 54 10,67	1,01
	115 Tauri	5 17 7,68	
	119 Tauri	5 22 7,46	
January 25.	β Libræ	15 7 31,35	0,99
	Moon 2 L.	15 28 37,90	

Day.	Name.	Time of Transit. h m s	Clock's losing rate. s
February 9.	(4) Ceti	3 1 26,61	
	ξ Tauri	3 17 22,25	1,07
	Moon 1 L	3 28 50,93	
	48 Tauri	4 5 32,38	
14.	Moon 1 L	8 44 26,06	
	π^3 Cancri	9 5 10,42	0,80
	(74) Leonis	9 15 27,17	
15.	π^3 Cancri	9 5 9,88	0,60
	(74) Leonis	9 15 26,52	
	Moon 1 L	9 46 34,31	
	Moon 2 L	9 48 55,14	
	α Leonis	9 58 38,09	
23.	φ Ophiuchi	16 20 35,60	0,96
	Moon 2 L	16 48 28,61	
	η Ophiuchi	16 59 48,60	

Jan. 15. Observed the re-appearance of *Jupiter's* 1st satellite, with a $3\frac{3}{4}$ inch Dollond. The telescope was badly mounted, and the satellites were very faint, as the planet was low in haze and the Moon bright. The satellite first seen at $1^h\ 28^m\ 36^s,35$, Cambridge sidereal time, or $5^h\ 51^m\ 28^s,08$ Greenwich mean solar time.

Jan. 20. Observed the disappearance of *Saturn* at the Moon's bright limb, and the re-appearance at the dark limb. From the faintness of the planet, the times of contact could not be observed; and the times of bisection of its centre by the Moon's limb may be inaccurate several seconds. The planet was judged to be bisected on disapp. at $5^h\ 17^m\ 6^s$; on re-app. at $5^h\ 28^m\ 7^s$ Camb. sid. time.

Jan. 25. Disappearance of *γ Libræ* at the Moon's bright limb, at $13^h\ 32^m\ 16^s,82$ Camb. sid. time. Re-appearance at the dark limb, at $14^h\ 50^m\ 22^s,27$. Very good observations.

Feb. 10. Disappearance of *Aldebaran* at the dark limb $1^h\ 58^m\ 46^s,49$ Cambridge sidereal time; very certain observation. Re-appearance at $3^h\ 8^m\ 35^s,23$. This was observed with too low a power; but I believe it is very good.

Among the presents announced this evening was a repeating Theodolite, by T. Jones, of Charing Cross, with horizontal circle of 20 inches diameter, graduated on silver, reading off to seconds by 3 micrometer microscopes, attached to a frame concentric with the circle, and on the same axis; with 30-inch transit telescope, with levels and divided circle, as in the great Theodolite of the trigonometrical survey. This valuable instrument was presented by J. Fuller, Esq. Fellow of the Society.

J. Moyes, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

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An Ephemeris of the Stars proper to be observed with Mars, *at the ensuing Opposition of that Planet.*

1832.	Stars.	Mag.	Apparent Place.		Semidiameter.		Hor. Par.
			Right Ascens.	Declin. *North.*	In time.	In arc.	
			h m s	° ′ ″	s	″	″
Oct. 11	53 Tauri	6·7	4 9 34,69	20 43 48,0			
	* —— (*o*)	8	16 23,90	21 4 56,7			
	Mars[2]	N	22 55,23	20 36 55,1	0·586	8,22	14,71
12	53 Tauri	6·7	4 9 34,71	20 43 48,1			
	* —— (*o*)	8	16 23,92	21 4 56,8			
	Mars[2]	S	22 59,00	20 39 22,5	·590	8,28	14,82
13	53 Tauri	6·7	4 9 34,74	20 43 48,1			
	* —— (*o*)	8	16 23,95	21 4 56,8			
	Mars[2]	N	22 59,07	20 41 44,0	·594	8,34	14,92
14	53 Tauri	6·7	4 9 34,76	20 43 48,2			
	* —— (*o*)	8	16 23,97	21 4 56,8			
	Mars[2]	S	22 55,40	20 43 59,6	·599	8,40	15,03
15	53 Tauri	6·7	4 9 34,78	20 43 48,2			
	* —— (*o*)	8	16 23,99	21 4 56,9			
	Mars[2]	N	22 47,94	20 46 9,3	·603	8,46	15,14
16	53 Tauri	6·7	4 9 34,81	20 43 48,3			
	* —— (*o*)	8	16 24,02	21 4 57,0			
	Mars[2]	S	22 36,66	20 48 12,9	·607	8,51	15,24
17	53 Tauri	6·7	4 9 34,83	20 43 48,3			
	* —— (*o*)	8	16 24,04	21 4 57,0			
	Mars[2]	N	22 21,55	20 50 10,4	·612	8,57	15,34

1832.	Stars.	Mag.	Apparent Place.		Semidiameter.		Hor. Par.
			Right Ascens.	Declin. *North.*	In time.	In arc.	
			h m s	° ′ ″	s	″	″
Oct. 18	53 Tauri	6·7	4 9 34,85	20 43 48,4			
	* —— (*c*)	8	16 24,07	21 4 57,1			
	Mars[2]	S	22 2,59	20 52 1,7	0·616	8,63	15,44
19	53 Tauri	6·7	4 9 34,87	20 43 48,4			
	* —— (*c*)	8	16 24,09	21 4 57,1			
	Mars[2]	N	21 39,77	20 53 46,2	·620	8,69	15,54
20	53 Tauri	6·7	4 9 34,90	20 43 48,5			
	* —— (*c*)	8	16 24,11	21 4 57,2			
	Mars[2]	S	21 13,09	20 55 24,0	·624	8,74	15,63
21	53 Tauri	6·7	4 9 34,92	20 43 48,5			
	* —— (*c*)	8	16 24,14	21 4 57,2			
	Mars[2]	N	20 42,55	20 56 55,0	·628	8,79	15,73
22	53 Tauri	6·7	4 9 34,94	20 43 48,6			
	* —— (*c*)	8	16 24,16	21 4 57,3			
	Mars[2]	S	20 8,18	20 58 19,1	·632	8,84	15,83
23	53 Tauri	6·7	4 9 34,96	20 43 48,6			
	* —— (*c*)	8	16 24,18	21 4 57,3			
	Mars[2]	N	19 30,01	20 59 36,3	·636	8,90	15,93
24	53 Tauri	6·7	4 9 34,98	20 43 48,7			
	* —— (*c*)	8	16 24,20	21 4 57,4			
	Mars[2]	S	18 48,06	21 0 46,3	·640	8,95	16,02
25	53 Tauri	6·7	4 9 35,00	20 43 48,7			
	* —— (*c*)	8	16 24,22	21 4 57,4			
	Mars[2]	N	18 2,39	21 1 49,1	·643	9,00	16,12
26	51 Tauri	6·7	4 8 29,99	21 9 47,6			
	* —— (*c*)	8	16 24,25	21 4 57,4			
	Mars[2]	S	17 13,06	22 2 44,4	·647	9,05	16,20
27	51 Tauri	6·7	4 8 30,01	21 9 47,6			
	Mars[2]	N	16 20,15	21 3 32,1	·650	9,10	16,28
	* Tauri (*c*)	8	16 24,27	21 4 57,5			

1832.	Stars.	Mag.	Apparent Place.		Semidiameter.		Hor. Par.
			Right Ascens.	Declin. *North.*	In time.	In arc.	
			h m s	° ′ ″	s	″	″
Oct. 28	51 Tauri	6·7	4 8 30,03	21 9 47,6			
	Mars[2]	S	15 23,73	21 4 11,9	0·653	9,14	16,35
	* Tauri (*c*)	8	16 24,29	21 4 57,5			
29	51 Tauri	6·7	4 8 30,05	21 9 47,7			
	Mars[2]	N	14 23,89	21 4 43,9	·656	9,18	16,42
	* Tauri (*c*)	8	16 24,31	21 4 57,6			
30	51 Tauri	6·7	4 8 30,07	21 9 47,8			
	Mars[2]	S	13 20,74	21 5 7,8	·659	9,22	16,49
	* Tauri (*c*)	8	16 24,33	21 4 57,6			
31	51 Tauri	6·7	4 8 30,09	21 9 47,8			
	Mars[2]	N	12 14,38	21 5 23,8	·661	9,26	16,56
Nov. 1	A[1] Tauri	5	3 54 49,28	21 37 1,3			
	Mars[2]	N	4 11 4,93	21 5 31,7	·664	9,29	16,62
2	A[1] Tauri	5	3 54 49,30	21 37 1,4			
	Mars[2]	S	4 9 52,50	21 5 31,4	·666	9,32	16,67
3	A[1] Tauri	5	3 54 49,31	21 37 1,4			
	Mars[2]	N	4 8 37,25	21 5 22,9	·668	9,35	16,72
4	A[1] Tauri	5	3 54 49,33	21 37 1,5			
	Mars[2]	S	4 7 19,30	21 5 6,2	·670	9,38	16,77
5	A[1] Tauri	5	3 54 49,35	21 37 1,5			
	Mars[2]	N	4 5 58,81	21 4 41,2	·671	9,41	16,81
6	A[1] Tauri	5	3 54 49,36	21 37 1,6			
	Mars[2]	S	4 4 35,92	21 4 7,8	·673	9,43	16,84
7	A[1] Tauri	5	3 54 49,38	21 37 1,6			
	Mars[2]	N	4 3 10,81	21 3 26,3	·674	9,45	16,87
	53 Tauri	6·7	9 35,25	20 43 49,2			
8	A[1] Tauri	5	3 54 49,39	21 37 1,7			
	Mars[2]	S	4 1 43,65	21 2 36,7	·675	9,46	16,90
	53 Tauri	6·7	9 35,27	20 43 49,3			

1832.	Stars.	Mag.	Apparent Place.		Semidiameter.		Hor. Par.
			Right Ascens.	Declin. *North.*	In time.	In arc.	
			h m s	° ′ ″	s	″	″
Nov. 9	A¹ Tauri	5	3 54 49,41	21 37 1,7			
	Mars²	N	4 0 14,61	21 1 38,9	0·676	9,47	16,92
	53 Tauri	6·7	9 35,29	20 43 49,3			
10	A¹ Tauri	5	3 54 49,43	21 37 1,8			
	Mars²	S	58 43,88	21 0 33,2	·676	9,48	16,93
	53 Tauri	6·7	4 9 35,30	20 43 49,3			
11	* Tauri (*b*)	8	3 47 23,56	20 49 51,1			
	Mars²	N	57 11,67	20 59 19,7	·677	9,48	16,94
	53 Tauri	6·7	4 9 35,32	20 43 49,4			
12	* Tauri (*b*)	8	3 47 23,57	20 49 51,1			
	Mars²	S	55 38,15	20 57 58,5	·677	9,48	16,95
	53 Tauri	6·7	4 9 35,34	20 43 49,4			
13	* Tauri (*b*)	8	3 47 23,59	20 49 51,1			
	Mars²	N	54 3,55	20 56 30,0	·677	9,47	16,94
	53 Tauri	6·7	4 9 35,35	20 43 49,4			
14	* Tauri (*b*)	8	3 47 23,60	20 49 51,2			
	Mars²	S	52 28,07	20 54 24,2	·676	9,46	16,94
	53 Tauri	6·7	4 9 35,37	20 43 49,4			
15	* Tauri (*b*)	8	3 47 23,61	20 49 51,2			
	Mars²	N	50 51,93	20 53 11,6	·675	9,45	16,92
	53 Tauri	6·7	4 9 35,38	20 43 49,5			
16	* Taur (*b*)	8	3 47 23,62	20 49 51,2			
	Mars²	S	49 15,35	20 51 22,6	·674	9,44	16,90
	A¹ Tauri	5	54 49,51	21 37 2,0			
17	* Tauri (*b*)	8	3 47 23,64	20 49 51,3			
	Mars²	N	47 38,55	20 49 27,7	·673	9,42	16,87
	A¹ Tauri	5	54 49,52	21 37 2,0			
18	Mars²	S	3 46 1,77	20 47 27,4	·671	9,40	16,83
	* Tauri (*b*)	8	47 23,65	20 49 51,3			
	A¹ ——	5	54 49,54	21 37 2,1			

1832.	Stars.	Mag.	Apparent Place.		Semidiameter.		Hor. Par.
			Right Ascens.	Declin. *North.*	In time.	In arc.	
			h m s	° ′ ″	s	″	″
Nov. 19	Mars[2]	N	3 44 25,23	20 45 22,0	0·669	9,38	16,79
	* Tauri (*b*)	8	47 23,66	20 49 51,3			
	A[1] ——	5	54 49,55	21 37 2,1			
20	Mars[2]	S	3 42 49,15	20 43 12,0	·667	9,35	16,74
	* Tauri (*b*)	8	47 23,67	20 49 51,4			
	A[1] ——	5	54 49,56	21 37 2,1			
21	Mars[1]	N	3 41 13,76	20 40 58,1	·664	9,32	16,69
	* Tauri (*b*)	8	47 23,68	20 49 51,4			
	A[1] ——	5	54 49,57	21 37 2,2			
22	Mars[1]	S	3 39 39,27	20 38 40,9	·662	9,29	16,63
	* Tauri (*b*)	8	47 23,69	20 49 51,4			
	A[1] ——	5	54 49,58	21 37 2,2			
23	F[1] Tauri	6·7	3 32 41,40	19 9 31,9			
	Mars[1]	N	38 5,93	20 36 21,0	·659	9,26	16,56
	32 Tauri	6	47 0,26	21 59 25,0			
24	F[1] Tauri	6·7	3 32 41,41	19 9 31,9			
	Mars[1]	S	36 33,94	20 33 59,3	·656	9,22	16,49
	32 Tauri	6	47 0,26	21 59 25,0			
25	* Tauri (*a*)	9	3 29 18,97	20 21 54,1			
	Mars[1]	N	35 3,49	20 31 36,4	·653	9,18	16,42
	32 Tauri	6	47 0,27	21 59 25,0			
26	* Tauri (*a*)	9	3 29 18,98	20 21 54,1			
	Mars[1]	S	33 34,80	20 29 12,8	·649	9,13	16,33
	32 Tauri	6	47 0,28	21 59 25,1			
27	* Tauri (*a*)	9	3 29 18,99	20 21 54,1			
	Mars[1]	N	32 8,03	20 26 49,4	·646	9,09	16,24
	32 Tauri	6	47 0,28	21 59 25,1			
28	* Tauri (*a*)	9	3 29 18,99	20 21 54,2			
	Mars[1]	S	30 43,35	20 24 26,9	·642	9,04	16,15
	32 Tauri	6	47 0,29	21 59 25,1			

1832.	Stars.	Mag.	Apparent Place.		Semidiameter.		Hor. Par.
			Right Ascens.	Declin. *North.*	In time.	In arc.	
			h m s	° ′ ″	s	″	″
Nov. 29	65 Arietis	6	3 14 48,28	20 12 19,6			
	* Tauri (*a*)	9	29 19,00	20 21 54,2			
	Mars[1]	N	29 20,94	20 22 6,0	0·638	8,98	16,05
30	65 Arietis	6	3 14 48,29	20 12 19,6			
	Mars[1]	S	28 0,93	20 19 47,3	·634	8,92	15,95
	* Tauri (*a*)	9	29 19,00	20 21 54,2			
Dec. 1	65 Arietis	6	3 14 48,29	20 12 19,6			
	Mars[1]	N	26 43,48	20 17 31,4	·630	8,86	15,85
	* Tauri (*a*)	9	29 19,01	20 21 54,2			
2	65 Arietis	6	3 14 48,29	20 12 19,6			
	Mars[1]	S	25 28,68	20 15 19,1	·625	8,80	15,74
	* Tauri (*a*)	9	29 19,01	20 21 54,2			
3	65 Arietis	6	3 14 48,30	20 12 19,6			
	Mars[1]	N	24 16,67	20 13 10,8	·621	8,73	15,63
	* Tauri (*a*)	9	29 19,02	20 21 54,3			
4	65 Arietis	6	3 14 48,30	20 12 19,7			
	Mars[1]	S	23 7,55	20 11 7,1	·616	8,66	15,51
5	65 Arietis	6	3 14 48,30	20 12 19,7			
	Mars[1]	N	22 1,42	20 9 8,6	·611	8,60	15,39
	F[1] Tauri	6·7	32 41,47	19 9 32,1			
6	65 Arietis	6	3 14 48,30	20 12 19,7			
	Mars[1]	S	20 58,33	20 7 15,7	·606	8,53	15,27
	F[1] Tauri	6·7	32 41,47	19 9 32,1			
7	65 Arietis	6	3 14 48,30	20 12 19,7			
	Mars[1]	N	19 58,38	20 5 29,0	·601	8,46	15,15
	F[1] Tauri	6·7	32 41,48	19 9 32,1			
8	65 Arietis	6	3 14 48,30	20 12 19,7			
	Mars[1]	S	19 1,62	20 3 48,7	·596	8,39	15,02
	F[1] Tauri	6·7	32 41,48	19 9 32,1			

1832.	Stars.	Mag.	Apparent Place.		Semidiameter.		Hor. Par.
			Right Ascens.	Declin. *North.*	In time.	In arc.	
			h m s	° ′ ″	s	″	″
Dec. 9	65 Arietis	6	3 14 48,31	20 12 19,8			
	Mars[1]	N	18 8,11	20 2 15,4	0·591	8,32	14,89
	F[1] Tauri	6·7	32 41,48	19 9 32,1			
10	65 Arietis	6	3 14 48,31	20 12 19,8			
	Mars[1]	S	17 17,89	20 0 49,5	·586	8,25	14,76
	F[1] Tauri	6·7	32 41,48	19 9 32,1			
11	(38) Arietis	8	3 11 15,80	19 54 0,6			
	65 ——	6	14 48,31	20 12 19,8			
	Mars[1]	N	16 31,00	19 59 31,3	·581	8,18	14,63
12	(38) Arietis	8	3 11 15,80	19 54 0,6			
	65 ——	6	14 48,31	20 12 19,8			
	Mars[1]	S	15 47,47	19 58 21,2	·575	8,10	14,49
13	(38) Arietis	8	3 11 15,80	19 54 0,6			
	65 ——	6	14 48,30	20 12 19,8			
	Mars[1]	N	15 7,33	19 57 19,5	·570	8,02	14,36
14	(38) Arietis	8	3 11 15,80	19 54 0,7			
	Mars[1]	S	14 30,62	19 56 26,4	·564	7,94	14,22
	65 Arietis	6	14 48,30	20 12 19,8			
15	(38) Arietis	8	3 11 15,80	19 54 0,7			
	Mars[1]	N	13 57,33	19 55 42,1	·558	7,87	14,09
	65 Arietis	6	14 48,30	20 12 19,8			
16	(38) Arietis	8	3 11 15,80	19 54 0,7			
	Mars[1]	S	13 27,49	19 55 6,9	·553	7,79	13,95
	65 Arietis	6	14 48,30	20 12 19,8			
17	(38) Arietis	8	3 11 15,79	19 54 0,7			
	Mars[1]	N	13 1,10	19 54 41,1	·548	7,72	13,81
	65 Arietis	6	14 48,30	20 12 19,8			
18	(38) Arietis	8	3 11 15,79	19 54 0,7			
	Mars[1]	S	12 38,15	19 54 24,6	·542	7,64	13,67
	65 Arietis	6	14 48,30	20 12 19,8			

1830.	Stars.	Mag.	Apparent Place.		Semidiameter.		Hor. Par.
			Right Ascens.	Declin. *North.*	In time.	In arc.	
			h m s	° ′ ″	s	″	″
Dec. 19	(38) Arietis	8	3 11 15,79	19 54 0,7			
	Mars[1]	N	12 18,64	19 54 17,8	0·536	7,56	13,54
	65 Arietis	6	14 48,29	20 12 19,8			
20	(38) Arietis	8	3 11 15,78	19 54 0,7			
	Mars[1]	S	12 2,56	19 54 20,9	·531	7,49	13,40
	65 Arietis	6	14 48,29	20 12 19,8			
21	(38) Arietis	8	3 11 15,78	19 54 0,7			
	Mars[1]	N	11 49,87	19 54 33,6	·526	7,41	13,26
	65 Arietis	6	14 48,29	20 12 19,8			
22	(38) Arietis	8	3 11 15,78	19 54 0,7			
	Mars[1]	S	11 40,61	19 54 56,4	·520	7,33	13,12
	65 Arietis	6	14 48,28	20 12 19,8			
23	(38) Arietis	8	3 11 15,77	19 54 0,7			
	Mars[1]	N	11 34,72	19 55 29,2	·515	7,25	12,99
	65 Arietis	6	14 48,28	20 12 19,8			
24	(38) Arietis	8	3 11 15,77	19 54 0,7			
	Mars[1]	S	11 32,18	19 56 11,9	·510	7,18	12,85
	65 Arietis	6	14 48,27	20 12 19,8			
25	(38) Arietis	8	3 11 15,76	19 54 0,7			
	Mars[1]	N	11 32,95	19 57 4,7	·505	7,10	12,71
	65 Arietis	6	14 48,27	20 12 19,8			

Previous to Mr. Henderson's departure for the Observatory at the Cape of Good Hope, (to which he has recently been appointed Astronomer, in the room of the late Rev. Fearon Fallows), he expressed a wish that a selection might be made of such stars as would be proper and convenient to be observed with *Mars*, at his ensuing opposition in November next; with a view to the determination of the parallax of that planet: and that a list of the same should be circulated amongst different astronomers in various parts of the world, for the purpose of obtaining corresponding observations.

Mr. Sheepshanks having furnished the apparent places of *Mars* (together with the semidiameter and horizontal parallax) for each day during the requisite period, Mr. Baily selected the stars agreeably to Mr. Henderson's wishes: and the Council of this Society, desirous of promoting, as much as lies in their power, an object which, if actively and properly followed up, may be attended with much advantage to the science of astronomy, have caused the same to be printed and circulated.

The positions of *Mars* are the *apparent* geocentric places (corrected for aberration) at mean midnight at *Berlin;* deduced from the Berlin ephemeris, using 5th differences in the computation. The positions of the stars also are their *apparent* places on the day of transit: Mr. Sheepshanks having furnished the daily corrections for precession, aberration, and nutation. These stars are selected in such manner that there may always be a sufficient interval of time between the transit of the star and the planet, to enable the observer to read off the divisions of the circle or micrometer; except in a few cases when they are both in the field of the telescope at the same time, or so nearly on the same parallel that one setting of the instrument will be sufficient for both observations, with the aid of a micrometer.

Mr. Henderson requests that, when both limbs of *Mars* cannot be conveniently observed on the same day, the *northern* limb should be observed on the *odd* days, and the *southern* limb on the *even* days of the month: as a guide to the observer, this is denoted by the letters N and S inserted in the column of magnitudes. Also, that the transit of the *second* limb should be observed *prior* to the day of opposition, and the transit of the *first* limb *after* that day: this is denoted by the figures 1 and 2 annexed to *Mars*.

Aldebaran should be observed on every night when the planet is observed.

Those astronomers, who are possessed of good equatorial instruments, may take *repeated* measures of the difference of declination between the selected star and the planet on the same night: noting, however, the times at which the observations were made.

The ephemeris is extended from October 11th to December 25th, for the purpose of including the stationary points of *Mars*, both in right ascension and declination.

The star (38) *Arietis* is to be found in Piazzi's catalogue: the small stars (*a*) (*b*) (*c*) are taken from Lalande's *Histoire Céleste*, page 33. The star (*b*) is the brightest, the most northerly, and the second of two stars that are distant from each other about 2′ in declination; and *between* which *Mars* will pass on November 17th. For this, and for two or three other proximate stars, the wire micrometer might be advantageously used in determining the difference of declination. The places of the larger stars are taken from the catalogue of this Society, and the constants there given are used in the reductions.

The following are the assumed mean places, on January 1, 1832, of the 10 stars selected for the comparisons; viz.

Star.	Mag.	Mean $\mathcal{R}$.	Mean D. *North.*
		h m s	° ′ ″
(38) Arietis	8	3 11 12,37	19 53 50,48
65 ——	6	14 44,87	20 12 9,87
* Tauri (*a*)	9	29 15,55	20 21 45,62
F[1] ——	6·7	32 38,01	19 9 23,82
32 ——	6	46 56,77	21 59 18,00
* —— (*b*)	8	47 20,25	20 49 44,88
A[1] ——	5	54 46,12	21 36 55,94
51 ——	7	4 8 26,98	21 9 43,42
53 ——	6·7	9 32,03	20 43 44,60
* —— (*c*)	8	16 21,26	21 4 53,84

Other quantities, used in the computations, are the following: viz.

Sun's horizontal parallax = 8″,578
Mean semidiameter of Mars = 4 ,790
Constant of aberration = 493ˢ,2

Berlin, East of Paris = 44ᵐ 12ˢ,6
———— of Greenwich = 53 34 ,1

*** Mr. Henderson was also desirous that some stars should be selected for observing the parallax of *Mars* in *right ascension*; agreeably to the method pointed out by Lalande, in his *Astronomie*, vol. ii. page 281: since *Mars* will be favourably situated, at the ensuing opposition, for such observations in the northern hemisphere. But there are no stars, near the path of the planet at that time, of sufficient magnitude for such purpose.

J. Moyes, 28, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *April* 13, 1832. No. 12.

THE following communications were read:—

I. Comparisons of the right ascension of *Polaris*, as obtained by observation, with that given in Bessel's catalogue for 1831; and observations of λ *Ursæ minoris* and 51 (Hevelius) *Cephei*, made with a 5-feet transit at Blackheath. By Mr. Wrottesley.

II. Mr. Sheepshanks gave an account of the mural circle, with the methods of using it hitherto followed, and a description of the state and defects of the circle at the Cape Observatory.

The Council of the London University were kind enough to lend their beautiful model of a mural circle, which was placed upon the table; but a sufficient idea of the construction of the instrument, omitting the nicer adjustments, may perhaps be obtained from the following description. It consists of a circle, not very unlike a cart-wheel, attached by its centre and at right angles to one end of a long hollow conical axis. Upon this axis are two well-turned fittings, one near the circle, the other at the further extremity, which work in collars* firmly fixed at the front and back of a massive stone wall or pier extending beyond the circle. The telescope is moveable upon the *face* of the circle, on an axis concentric to and working within the axis of the circle, and is held in any required position by strong clamps at the object and eye end. The divisions are cut on the edge of the circle (similarly to the milling upon our coin), and the reading microscopes are fixed against the pier. In large instruments there are generally six microscopes, at equal intervals of 60°. To relieve the bearing upon the collar, a pair of friction wheels support the axis immediately behind the circle, and thus a smooth and easy movement is secured. The friction wheels are suspended from one arm of a scale beam. The limb of the circle is turned upon its own axis (as on a lathe), upon which it is also divided after the method described by Mr. Troughton

* In the Cape mural, Y's were adopted instead of collars, with the expectation that the instrument would thus keep its meridian better. An objection has been made against this construction, that the circle when turned round would probably ride up the inclined planes. This would not seem to have been the case in the Cape circle, as the instrument, though very much deranged, gives at all times the same readings with each microscope at the same place; but the objection, as will be seen hereafter, is of no weight. The *riding* may easily be detected; and would not, on any reasonable supposition, affect the results.

in the *Phil. Trans.*, so that the divisions must be concentric with the axis. In every part of the instrument, of its pier and microscopes, the utmost firmness and stability have been aimed at.

For the purpose of setting the axis horizontal, two adjustable dots are fixed on the front of the telescope towards the extremities. A plumb-line is suspended from the top of the pier, and made to bisect the *images* of these points when the telescope is vertical; the instrument is then moved round 180°, and the plumb-line again applied and made to bisect one of the dots. If it also bisect the other, the axis is horizontal; but if not, the difference is to be halved by raising or depressing the further end of the axis, which is furnished with adjusting screws. The same operation may be performed, or the error measured, if the transits of stars be observed directly and by reflection.

The simplest mode of placing the line of sight at right angles with the axis would seem to be by employing a second or collimating telescope, as is practised at present at Greenwich with the transit itself. Let the centre wire of the circle telescope bisect a well-defined mark in the horizon, to the *South*, for instance; and let a telescope, furnished with cross wires, and moving on a horizontal axis, be placed to the *North* of the circle, in the same vertical plane with the mark and the circle. Then, if the cross wires of the collimating telescope be made to bisect the mark, and the circle be turned round so as to look down the collimating telescope, the cross wires should be bisected exactly as the mark was. One half the error, if any, is to be corrected by screws working in the wire plate of the circle telescope. Lastly, the centre wire, which now describes a great vertical circle, is made to pass through the pole, by observing the transits of circumpolar stars at the upper and lower culmination, or by any other method. The adjusting screws for this purpose are applied at the extremity of the axis.*

Objections have been made against this construction of the *declination circle:* one or two of which may be briefly noticed. The first is, that the circle being supported on one side, has only half an axis. The mischief to be apprehended from this, is the bending of the axis outwards and downwards from the point where the friction wheels bear, which would cause the plane of the instrument to be no longer at right angles to the axis, and therefore not in the meridian. The telescope would describe such a circle as a transit with an error of inclination. When, however, the strength of the axis (which is seven inches in diameter), and the shortness of the lever at which the weight acts, is considered, it is evident that the flexure must be very small; that this is remedied, so far as its mean value is concerned, by giving a corresponding inclination to the axis; and that the effect of such bending would not be sensible in measurements of declination except in stars very near the pole.

* If it be intended to use the instrument as a transit, these adjustments must be performed with scrupulous exactness; but a considerable error will not sensibly affect the accuracy of the results, when the instrument is employed in merely measuring declination. A third telescope will supply the place of a mark.

Another, and a better founded objection has been urged, which is, that, as the divisions are on the edge of the limb, they are not only affected in magnitude by temperature, but are brought nearer to, or removed further from, the microscopes, which causes an alteration in the *run* of the micrometer, and may produce considerable error. If this be so, the fact is easily ascertainable by trying the *runs* after considerable changes of temperature, and the error may be remedied by correcting each microscope, or their sum. Perhaps it would be prudent, at all events, to verify the runs from time to time by bisecting both the upper and lower divisions, as was frequently done by the Astronomer Royal when Troughton's mural was first erected.

Whatever weight, however, may be attached to these, or similar objections, would seem to be much more than balanced by the advantages peculiar to the instrument; viz. the superior firmness of its construction, allowing the use of larger dimensions with the application of higher optical power than can safely be employed in any other form of the circle; and the extreme steadiness of the microscopes, which continue unaltered, if not struck or meddled with.

When the mural circle was first erected at Greenwich, the Astronomer Royal, after many trials, adopted the mode of observation which is fully explained in the *Greenwich Observations*, Vols. I. and II. The details of this method have not been generally understood; but the principle may perhaps be explained thus. A certain number of stars are selected to form the standard catalogue, and their places in $\mathcal{R}$ and N.P.D. *assumed*. Let us further suppose the difference of the assumed from the *real* position of each star to consist of two parts, one, x, common to all the stars, or the mean of the differences between the assumed and *required* catalogues, and the other, the error proper to the individual star. Now, if the *whole* of these stars be observed on any day, in N.P.D. for instance, the difference of each observed place from the assumed place will be the index error of the instrument according to that star, and the mean of these index errors will be the real index error of the instrument $\pm x$. By using this quantity as the index error, the assumed place of each star is corrected for the second or individual portion of the error; and all that is further required is to ascertain the value of x. This increases the N.P.D. of stars above the pole, and diminishes that of stars below the pole, or *versâ vice*, and thus the value of x is equal to half the difference between the N.P. Distances of the same star above and below the pole. The method is less perfect when fewer stars are observed; but it is obvious, that when the observations of many days are employed, and nearly in the same number for each star, the result will be the same. The resulting catalogue is to be considered as *standard*, when the index error by every star above and below the pole is the same, allowing for errors of observation.*

* The mode of forming a catalogue in $\mathcal{R}$ is precisely the same, except that the mean error of the assumed places is to be obtained from observations of the

In this way the observations at Greenwich were conducted for some years, until a second mural circle was erected, made by Mr. Jones, and originally intended for the Cape Observatory. It is evident, that in the preceding method, the steadiness of the instrument with its microscopes, and a knowledge of the *variation* of refraction at different altitudes, and under different atmospheric conditions, are implied; and it is probably to avoid these assumptions that recourse has been had to the new system, which consists in obtaining double altitudes *at the same time* by using a reflecting surface of mercury. The circles are placed opposite to each other, and in every respect under the same circumstances. Let us suppose six or seven stars observed at each instrument in the same position, for instance by direct vision; and further, that the mean of the readings by Jones's circle exceeds the mean of the readings by Troughton's by 10″. If a star be now observed by Jones's *directly*, and by Troughton's by *reflexion* in a trough of mercury, it is clear that the reading of Jones' exceeds the reading which Troughton's would have shewn (if the star had been observed directly by that instrument) by 10″; or that if 10″ be subtracted from the reading of Jones', we may assume this for the reading of Troughton's circle, and suppose the star to have been observed by direct vision by the latter instrument: the difference between this *transferred* reading and that actually made is the apparent double altitude of the star.* In this method no dependence need be placed upon the stability of either instrument for any considerable time, and no knowledge of the refraction is required. In the opinion of the Astronomer Royal, it is a very sensible improvement upon the first method; but it can only be carried into effect where two observers can be appropriated to the circle.

At the Cape, as the pole is low and no stars visible in the day time within 10° of it, Mr. Fallows could not very safely apply Mr. Pond's first method, which implies, as is said above, a perfect knowledge of the difference of refraction of a star above and below the pole. He, therefore, observed the same stars on one day directly, and on another day by reflection, relying upon the stability of the instrument, pier, microscopes, &c. during this interval, and supposing the variation of refraction, at the same altitude, arising from pressure and temperature, to be sufficiently known. He thus obtained double altitudes from the observations of two days. To prove the steadiness of the instrument, observa-

equinoxes. The mean error in N.P.D. is similar to a wrongly-assumed situation of the pole, and that in Æ corresponds to a wrong place of the first point of *Aries*.

* The half of these readings gives the place of the horizon upon the circle, and the constancy of this place as determined by different stars on the same night is a test of the goodness of the observations and of the equality of the divisions of the instrument. When the horizontal point continues unchanged for a long period, the stability of the pier, &c. may be concluded. To understand the manner of practically carrying into execution what has only been briefly hinted at above, the reader is referred to the *Greenwich Observations*, where all the details are fully exhibited.

tions of some stars were generally made in the same position of the circle, and the constancy of such readings shew that no sensible change took place for several weeks together. It will be seen that the only danger to be apprehended is, that the whole pier should move in one mass, round some horizontal axis, and this may easily be verified in the manner stated above. A derangement in one or two microscopes, or a change in the position of the centre of the circle, cannot escape the notice of any careful observer, and may be ascertained or corrected with certainty.

A fourth method has been suggested, but not attempted, at least with quick moving stars. After setting the instrument pretty nearly to the place of the star, by reflection for instance, and clamping it, the microscopes are to be read off, and the bisection of the star performed by a micrometer attached to the eye-piece. The clamp is then to be released, and the star bisected on the micrometer wire by direct vision, the slow motion being given to the instrument in the usual manner with the tangent screw, and the micrometer wire untouched. The difference of the two readings will give the double altitude of the star. Experience only can shew whether this mode of observing can be practised safely and without hurry, by one observer, with an instrument upon so large a scale as a 6-feet mural. With small circles there would be no difficulty, and if they have an azimuthal motion, the micrometer may be dispensed with.

Before describing the kind of injury which seems to have been sustained by the mural circle at the Cape, it seems advisable to make some preliminary observations, which will shew the nature of the evidence from which certain conclusions have been drawn.

Almost every person who has examined a circle by reading verniers, or microscopes, placed at 180° distance, will have remarked, that the readings are discordant, or do not differ by a constant angle. This is particularly the case in circles divided by engine, and is easily accounted for, when we consider that, though the circle may be accurately divided, there is no necessary connexion, at least in the English construction of the dividing engine, between the centre of the divided circle and the axis round which it, or the bar carrying the verniers, ultimately moves.* No error is caused by a defect of this nature, when opposite readings are employed. If the circle be fixed, and the verniers revolve, which is generally the case in theodolites, &c., we may imagine a vernier to pass through the centre of the divisions which is always parallel to the existing excentric vernier. This hypothetical vernier, if the circle were well divided, would give the same readings at each extremity, one of which would exceed the neighbouring reading of the real vernier by exactly the same quantity by which the other reading falls short of its companion. The means of the two verniers would coincide, which is also clear, from the consideration that the sum of

* M. Gambey has provided for this in his engine, by making the axis of the circle to be divided the axis of his machine; this is not done in Ramsden's construction, which has hitherto been followed in this country.

the readings of parallel chords must always be identical. Again, if the circle revolve, and the verniers or microscopes be fixed, as in the mural circle, it is evident that the raising or depressing the centre will not alter the sum of the readings of opposite microscopes, if the position of the telescope, or of any diameter, continue to be parallel with itself.* Whatever is lost at one microscope is gained by its opposite. The same is practically true† of three readings at 120° distance. Of course, four and six microscopes (as consisting of two and three pairs) remedy any defect of centering, which is, besides, so readily separated from errors of division that no fear need be entertained on this score. In some cases a little excentricity may be even useful in examining and checking the work of subordinate observers, who may not be sufficiently intelligent to forge consistent readings.

Another proposition (easily shewn from the series which expresses the arc of an ellipse of small excentricity) is, that if an equally divided circle be from any cause changed into a slightly elliptic form (without altering the length of its circumference, which continues to be a scale of equal parts); then, the reading of the ellipse by any microscope will be the reading of the original circle $+ m'' \times \sin 2\theta$, where m depends upon the extent of the derangement, and θ is the arc reckoned in the order of the divisions, and measured from the major axis of the ellipse. A little consideration of this expression‡ will shew, that two microscopes at 90° distance, three microscopes at 120° distance, and hence four and six microscopes at equal distances will give the same result, whether the original circle or the ellipse be employed; and therefore, that any injury to a circle which alters it to an ellipse without extending the limb, does no harm, if the proper number of microscopes be used, and in their proper places.

Again, if the plane of the circle be not placed at right angles with the axis, or, to use the workman's phrase, if the wheel reels and goes drunken, it would seem that the effect of this obliquity, when small, is precisely such as would be caused by supposing the circle to be elliptic, and would, therefore, produce no error, if the proper number of microscopes be used.

* Hence, a defective clamp, which alters the readings when applied, causes no error (since the bisection is made after clamping), unless the instrument slip before the microscopes are read.

† *i. e.* if the excentricity be so small, that, when divided by the radius, it may be assumed for arc or sine indifferently. The vernier and microscopes would be useless long before this limit could be approached.

‡ Let the reading of the first microscope be A°, and of the extremity of the major axis of the ellipse be B°, then the errors of the elliptic circle, when two microscopes of 90° distance are used, are

$$+ m''. \sin 2(A-B)^\circ \text{ and } + m''. \sin 2\left\{90 + A - B\right\}^\circ$$

which destroy each other: when three microscopes are employed, the errors are,

$$+ m''. \sin 2(A-B)^\circ, + m''. \sin 2(120 + A - B)^\circ, \text{and } + m''. \sin 2\left\{240 + A - B\right\}^\circ$$

which also destroy each other.

Hence, if a circle be originally well divided, and from any accident suffer such a change of shape as makes it an ellipse, or approximately so; though the centre work may be forced from its place, and the plane of the circle inclined to the axis, yet it is capable of performing good work, and this is the state in which Mr. Sheepshanks conceives the Cape mural to be.

Soon after the erection of the mural circle at the Cape Observatory, there were vague rumours of its performance being unsatisfactory; and Mr. Fallows, in letters to Mr. Jones and Mr. Troughton, complained grievously of the discrepancies of its readings, but without any distinct statement of their extent or nature. After a good deal of experience, however, he came to the conclusion, that the mean of the six readings was to be fully depended upon, apparently upon the following grounds: — 1. That the *horizontal point*, *i. e.* the midway point between the place of a star seen directly and that seen by reflexion, was the same, whether the star was high or low, to the north or south. This proves that the circle is symmetrical on each side of the horizontal diameter. 2dly, That the observed *differences* of the declinations of known stars agreed with the best standard catalogues; and 3dly, that the latitude of the Cape Observatory as determined by *β Hydri* above and below the pole, agreed exactly with that determined by using the stars of the *Berlin Ephemeris*. (The difference from that deduced by means of the catalogue of the N.A. may probably be attributed to the tables of refraction.) From an examination of the observations themselves, it is certain that the circle, pier, and microscopes, are exceedingly steady; the extreme differences in the place of any star, or in the horizontal point, when the mean of the six microscopes is used, scarcely ever exceeding 2″, and generally not being greater than 1″.

After the death of Mr. Fallows several of his paper-books were deposited at the Admiralty, and Mr. Sheepshanks was allowed by Captain Beaufort to inspect them. Along with some other experiments, a series of readings at every 10° was found (see the accompanying paper, Table I.), upon which the present examination is founded. To make these readings suit equal intervals of 10°, the *reduction* was first subtracted from each of the microscopes; the microscopes were then set at exactly 60° apart, by adding to, or subtracting from, each microscope a constant quantity, such, that the vertical columns, when added up, = 0; and, lastly, the opposite readings were classed together.* The result of these operations is exhibited in Table II. If the circle were perfect in its form and divisions, it is clear that the sum of each pair of opposite readings should now = 0; and as this is not the case, and as the mean of the six microscopes is supposed to shew the truth, the half sum may be considered as the error of the diameter. These half sums are

* It would enable a person to examine a mural circle with much greater ease if this were always done. The readings ought to be considered as those of three diameters, each of which is independent of the other two.

arranged under the heads of $\frac{A+B}{2}$, $\frac{D+E}{2}$, $\frac{C+F}{2}$, which are next to be considered.

In the first place, if the instrument be firm, and the derangement permanent and independent of gravity, the error of each diameter should be the same for any reading, and for that reading $+180°$, because the same divisions recur under opposite microscopes; and it will be seen that the readings $\frac{A+B}{2}$ are sensibly the same after 180° that they are after 0°, and that $\frac{D+E}{2}$, $\frac{C+F}{2}$, follow the same law. Also the error $\frac{A+B}{2}$ for any reading should be the same as $\frac{D+E}{2}$ for the same reading $+60°$, and also as $\frac{C+F}{2}$ for the same reading $+120°$; since the divisions which are under the microscopes A and B come under D and E when the instrument has been turned round 60°, and under C and F when it has been moved through 120°. Upon inspection they do appear to be *sensibly* the same, $\frac{A+B}{2}$ or $-5'',4$, the error of the diameter 0° to 180° being the same as $\frac{D+E}{2}$ opposite 60°, and not differing more than the errors of reading off from $-6'',1$, the value of $\frac{C+F}{2}$ found opposite to 120°. Hence it may safely be concluded, that the errors, from whatever cause they may arise, are permanent, and do not shift about with the revolution of the instrument. The circle, therefore, is not *flexible* or *loose*.

On running down any of these columns, it is scarcely possible not to notice the regularity of the error, which for $\frac{A+B}{2}$, as is readily seen, differs very little from $+5'',5 \times \sin 2\{\text{angle read off} - 45°\}$.* Now this is exactly similar to the error which would exist if the shape of the instrument was changed from a circle to an ellipse after it was divided; and as we know that the case in which it was packed *was let fall while raising from the hold of the ship* previous to landing, it seems reasonable to conclude that such an alteration of form did really

* The approximate curve being supposed to be an ellipse, which cannot be far from the truth, the positions of the major and minor axis were obtained by finding the readings, where the error would be 0, in each set of errors, and taking a mean of the different results. The major axis appears to be in the diameter $45° - 225°$. The value $5'',5$, in like manner, was determined by employing three observations about the maximum, for each partial result, and taking the mean of the whole. It did not appear worth while to adopt any more accurate method, as the readings are not to be relied upon to any great exactness, probably not much nearer than $1''$.

take place at that time. Table III. shews the near coincidence of this hypothesis with the actual errors.*

In this way we may ascertain the errors, which are similar to errors of division. The remaining errors can only arise from the varying position of the *centre of the divisions*, which must be carefully distinguished from the axis, or *centre of motion*. These are exhibited in Table IV., which is the same as Table II., after $\frac{A+B}{2}$, $\frac{D+E}{2}$, $\frac{C+F}{2}$ have been subtracted from the readings, A, B; D, E; C, F. The two columns of co-ordinates to the centre have been found as follows. The horizontal line joining the microscopes A and B has been assumed for the line of abscissæ. The ordinates are positive when the centre is above the line, which diminishes the reading of A and increases that of B. The abscissa is + when the centre approaches A, in which case the upper readings D and C are increased and the lower diminished. The centre will be found in three lines, the first parallel to the line joining the microscopes A and B, and distant from it, $\frac{B-A}{2}$; the second parallel to the line joining D, E, and distant from it by $\frac{D-E}{2}$; the third parallel to the line joining C and F, and distant from it by $\frac{C-F}{2}$: thus, we have three intersections for the position of the centre: $x = \frac{D+C}{2} \times \text{sec. } 30°$. To save trouble, y has simply been taken = B. The form of the curve thus traced out by the centre is exceedingly irregular and perplexing, but there is no appearance of any slipping, which would be shewn by a breach of continuity in the curve, or of riding, when the path of the centre would be in two lines parallel to the sides of the Y's. Upon examining the readings of the circle when employed in actual observation, the centre is always found pretty nearly in the position which is given by this curve, so that this error may be considered to be *fixed*, as well as the derangement of the circle itself, and all suspicion of slipping or riding, &c. be dismissed as groundless. By supposing the axis to be bent, and to work within two Y's of considerable length, or by supposing the pivot itself to have become elliptical, it may be possible to account even for this irregularity; but the research is one of some difficulty. To obtain a satisfactory solution it would perhaps be necessary to possess a set

* It can hardly be supposed that a fall should change a circle into an *accurate* ellipse, and the approximation is as satisfactory as under the circumstances can be expected. The circle may be of a pear or egg shape. If the shock took place when the circle was vertical and axis horizontal, it seems probable that the elongation would be in the diameter then vertical, and that the whole mass was carried below the former centre, *i. e.* the axis, which became excentric and crooked, or perhaps elliptic. The error is too large to be explained by an inclination of the plane of the circle to the axis, which would however produce a *similar* effect.

of transit observations, direct and by reflection, which we do not find in Mr. Fallow's MSS. No heavenly body, except the moon, can be sensibly affected by the slight deviation thus caused from the true meridian, which is indeed vexatious to the observer, by compelling him in all cases to read his minutes as well as seconds, but not otherwise important.* The centre may be made more steady, if the wandering arise from the crookedness of the axis, by shortening the bearings of the front Y's very much, and by fitting a new ring upon the further end of the axis, which may be adjusted to have its axis in the prolongation of the front bearing; or this end of the axis may be made to work against a point, in which way a new axis could be given perpendicular to the plane of the circle. Whether this or any similar plan be adopted, it seems certain that the Cape circle will give good results, although the separate microscopes are exceedingly discordant; and as it has been found that in every instrument, a wandering or excentricity of the centre is remedied by using opposite readings; that a change of form from the circular to the elliptic is not injurious, within reasonable limits, if the limb of the instrument continue to be a scale of equal parts, and if the proper number of microscopes be placed in fitting situations; and, finally, that even an inclination of the plane of the circle to the axis, will not invalidate the mean of the readings; we may conclude, that, with proper care and precaution, circles may be used successfully, even if somewhat deranged, when the original division has been carefully executed.

III. A list of stars observed with the moon at the Royal Observatory, Greenwich, March 1832.

		h m s	Daily Rate of Transit Clock.
March 9.	*m* Tauri	4 58 13,88	
	☽ 1 L.	5 10 53,88	
	119 Tauri	5 23 4,36	+0ˢ,15
	N Tauri	5 38 20,98	
10.	N Tauri	5 38 22,00	
	☽ 1 L.	6 13 7,34	+0ˢ,15
	ζ Geminorum	6 54 51,16	
11.	ζ Geminorum	6 54 51,32	
	☽ 1 L.	7 16 23,22	−0ˢ,14
	g Geminorum	7 37 6,54	
12.	*g* Geminorum	7 37 6,54	
	ζ Cancri	8 3 17,44	
	☽ 1 L.	8 19 20,90	+0ˢ,17
	o' Cancri	8 48 35,86	
13.	*o'* Cancri	8 48 35,86	
	☽ 1 L.	9 20 44,54	
	† ϒ Leonis	9 49 54,97	0ˢ,00
	Regulus	10 0 8,80	
15.	*l* Leonis	10 41 9,28	
	☽ 1 L.	11 16 15,70	0ˢ,00
	ϒ Virginis	11 37 57,42	

* This may be avoided by using a small table shewing the difference between A and the mean of the six microscopes at every 10°.

† At three wires only, *cloudy*.

IV. Transits of the moon with moon-culminating stars observed at Cambridge, in the month of May, 1832.

Day.	Name.	Time of Transit. h m s	Clock's losing rate. s
March 10.	N Tauri	5 37 22,07	1,30
	☽ 1 L.	6 12 7,15	
	ζ Geminorum	6 53 52,26	
11.	ζ Geminorum	6 53 50,89	1,30
	☽ 1 L.	7 15 21,77	
12.	*g* Geminorum	7 36 4,88	1,23
	ζ¹ Cancri	8 2 15,55	
	☽ 1 L.	8 18 18,03	
13.	☽ 1 L.	9 19 40,20	0,97
	ϑ Leonis	9 48 51,25	
	Regulus	9 59 5,73	
15.	*l* Leonis	10 40 4,21	0,85
	☽ 1 L.	11 15 9,54	
	ϑ Virginis	11 36 52,43	

Mr. Baily stated, in reference to Dr. Robinson's paper "On the dependence of a clock's rate on the height of the barometer," read in June last, that he had recently swung the mercurial pendulum in a vacuum apparatus, and found that a variation of one inch in the pressure of the atmosphere produced a difference of 0·42 seconds a-day in the rate of the pendulum; which is more than double the quantity deduced by Dr. Robinson from the *observed* alteration of rate when compared with the height of the barometer.

J. Moyes, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *May* 11, 1832. No. 13.

THE following communications were read:—

I. On the transit of *Mercury* which took place on the 5th instant.

1. *Greenwich.*—The Astronomer Royal obtained a very satisfactory observation of the immersion of the centre. The instrument selected was the eastern (or Sir George Shuckburgh's) equatorial. furnished with a beautiful double-threaded micrometer by Dollond. The sun's limb was made to run along the equatorial wire of the instrument, and the movable wire was adjusted to the path of *Mercury* as nearly as possible, by a previous calculation of Mr. Richardson. So nearly was this operation performed, that on the momentary appearance of the planet it was almost bisected by the wire. The versed sine of the chord thus measured by the micrometer was found equal to 2′ 34″,5, the mean time of internal contact $21^h\ 2^m\ 55^s,76$, and the diameter of *Mercury*, by a mean of 3 measures, 11″,38.

Mr. Simms, of the Royal Observatory, remarks, "I did not see *Mercury* till after the external contact, and immediately observed two arms of light extending from the sun and forming round the planet, and at length the whole of his disk became visible, before the internal contact was complete. I afterwards observed, that immediately round the planet there was a dusky tinge, making it appear as if, in a small degree, sunk below the sun's surface; I compared it in my mind at the time, to a piece of coin pressed hard upon an elastic sphere."

Mr. Simms also gives a sketch of the appearance of *Mercury* on the sun, in which the planet is surrounded by a halo.

2. *Greenwich Hospital, Long.* $0^s{\cdot}8$ W., *Lat.* 51° 28′ 52″ N.—Mr. Riddle observed *Mercury* completely on the sun's disc, rather within, at $21^h\ 3^m\ 53^s$. "I directed my attention particularly to observe whether round the little black patch there was any shade which might be supposed to be produced by the planet's atmosphere, and my impression is, that the appearance of the solar disk round the planet was such as an atmosphere might be expected to produce. Vision in my telescope was very distinct, but still, from its limited power, it is quite possible that the appearances which I noticed might be illusory."

3. *Observatory, Exchequer Street, Dublin, Long.* 25ˢ·4 W., *Lat.* 53° 20′ 56″ N.—The sun's centre was on the meridian at 2ʰ 50ᵐ 24ˢ,15, and that of *Mercury* at 2ʰ 50ᵐ 9ˢ,9. The clock error was 25ˢ,30 fast, and rate 0ˢ,2 daily.

4. *Fleet Street.*—Mr. Simms obtained from two micrometrical measures 10″,89 and 11″,55, for the diameter of *Mercury*. Of these, he prefers the second.

II. Observations of the Occultation of *Saturn* on the 8th instant.

1. *Greenwich Naval Hospital.*—By Mr. Riddle.

	h	m	s
Immersion of the west limb of *Saturn* ...	9	6	11,5
Ditto east ditto ditto		7	7,0
Ditto east end of the ring		7	38,0

2. *Islington.*—By Mr. Simms. Achromatic 5½ feet, aperture 3¾, power 160.

Immersion.	h	m	s	Emersion.
Western extremity of ring ...	12	12	1,0	
Western limb	12	12	22,0	
Eastern limb	12	13	2,0	13ʰ 12ᵐ 59ˢ,3

E. extreme ring obscured by cloud.

The immersion was remarkably beautiful, not the slightest distortion, projection, change of colour, or diminution of light, was evident. The moon's dark limb perfectly sharp and well defined upon the body of *Saturn*, which disappeared with a steady and uniform motion. At emersion the planet was but dimly seen; its form, however, was perfect, and its motion regular.

3. *Bedford.*—By Captain Smyth.

	h	m	s
Preceding limb of *Saturn's* ring touched by the dark disk of the moon.....	12	09	39,12
Preceding limb of *Saturn*	12	09	57,72
Following limb of *Saturn*	12	10	59,22
Following limb of the ring	12	11	25,12

4. *Lapley, near Brewood, Staffordshire.*—By the Rev. M. Ward.

Sidereal. h	m	s	
12	0	0,18	Leading ansa of *Saturn's* ring touched the moon's limb; the sky perfectly clear.
12	0	40,18	Ansa completely occulted, a thin film then passing.
12	1	6,18	Complete occultation of the body of *Saturn;* the film increased.
12	1	44,18	Complete occultation of extreme point of following ansa; the film increased and become yellow; in a few minutes the moon was obscured by clouds, and continued so nearly half an hour.
13	0	40	A very faint light, resembling the light in the moon's disc called Aristarchus, about twice as broad as the ansa, but not in the least defined. While adjusting the focus of the telescope the body of the planet appeared, and in the mean time the edge of a dense cloud passed, and at
13	1	50	The cloud had passed away, leaving the sky perfectly clear, and the edge of the planet about a whole diameter of the ring distant from the moon.

The first three observations must, from circumstances, be taken with allowance for estimation. The fourth was the instant of disappearance, together with its decimal. The estimation of a portion of a second, and the quantity of immersion, might have appeared to another observer, with a superior instrument, somewhat different in the first three observations. The faint light, or dawn-like appearance of the fifth observation, leaves the time the planet was occulted subject to some uncertainty.

III. Observations of the Occultation of 119 and 120 *Tauri*, March 9, 1832, at Islington. By Mr. Simms.

The night was remarkably fine, and the dark limb of the moon distinctly visible, the disappearance of the star 119 perfectly instantaneous, and in about 36 minutes of time 120 was in contact with the limb; the star appeared first to shoot forward a distance equal to about twice its own apparent diameter within the moon's border, and in this situation, after declining and reviving in brilliancy several times, gradually faded out of sight: a period of 12 seconds elapsed between the time when its occultation was expected and that when it actually occurred.

Mr. Simms is inclined to attribute the phenomenon of projection to local circumstances partially distributing upon the surface of the moon a medium of great refractive power.

IV. Correction of the Formulæ for determining the Longitude from an observed Occultation, with Suggestions for simplifying the Application of these and other Formulæ to the case of corresponding Observations. By Mr. Riddle.

In a former paper (See *Memoirs*, Vol. IV. Part II.), Mr. Riddle had employed the co-ordinate of the parallax, in the direction of the star's polar distance, for correcting the geocentric place of the point on the lunar disk at which the star was occulted. But, in dealing with a parallax so large as that of the moon, this co-ordinate may differ too sensibly from the true correction. Mr. Riddle gives the following quantity x'', to be added to the correction aforesaid when the star's declination is north, and substracted when it is south:

$$\text{Log. } x = 2 \text{ Log. } b + \text{Log. cot. } a + 4{\cdot}384545;$$

where a is the north polar distance to be corrected, and b is the number of seconds in the perpendicular let fall from the true point of occultation upon the hour circle of the same point, affected by parallax; no sensible error arising from using an arc of a great circle instead of the corresponding parallel of declination.

Mr. Riddle annexes a table from which the same correction may be found by inspection.

V. Observations of Eclipses of *Jupiter's* Satellites, and Occultations between the years 1827 and 1832, and Measures of Double Stars taken in 1831 and 1832. Also, Observations of the Comet of Ophiuchus, in Jan. 1831. By the Rev. W. R. Dawes, communicated by Sir J. F. W. Herschel.

Mr. Dawes has not been able to notice any projection on the moon's limb. On the occultation of *Jupiter*, June 1, 1831, he remarks:—"The satellites did not appear *instantaneously* at their full brilliance. From the instant when the emersion of *Jupiter* commenced, its size was beautifully defined, being uniformly bright, and perfectly free from distortion up to the very limb of the moon, in which several minute irregularities were visibly projected on the limb of the planet."

Mr. Dawes obtained the following observations of the comet:

	Mean Time.	
Jan. 24th	$18^h\ 25^m$	Dec. $7°\ 0'\ 24''$ S.
	$19^h\ 0^m$	$\text{Æ}\ 16^h\ 19^m\ 23^s$
25th	$18^h\ 52^m$	Dec. $6°\ 34'\ 40''$ S.
	$19^h\ 3^m$	$\text{Æ}\ 16^h\ 14^m\ 30^s$

VI. A New Method of Reducing the Apparent Distance of the Moon from a Star to the True. By Baron Zach.

This method consists in applying to the apparent distance four corrections, as follows: Let D be the apparent distance; A the mean of the apparent and true altitudes of the star; a the same of the moon; C and c the difference between the true and apparent altitudes of the same; and let $S = D + A + a$. Let d and e be found from the following equations:

$$\sin d = \frac{\cos \frac{1}{2} S \sin (\frac{1}{2} S - a)}{\sin D \cos A} \sin C$$

$$\sin e = \frac{\cos \frac{1}{2} S \sin (\frac{1}{2} S - A)}{\sin D \cos a} \sin c$$

Then, true distance $= D + C - c - d + e$.

The result is considered by Baron Zach as sufficiently near for the purposes of navigation; if, however, greater precision be required, let the first approximation be $D - R$, and repeat the process after diminishing $\frac{1}{2} S$, $\frac{1}{2} S - a$, and $\frac{1}{2} S - A$ respectively, by $\frac{1}{4} R$, and D by $\frac{1}{2} R$. The second result will not differ by $1''$ from that of the exact trigonometrical formula. Baron Zach gives eight instances of the results of his first approximation, five of which do not differ from the truth by $1''$, the errors of the other three being $+1''$, $-1''$, and $+4''$.

VII. A Method of Finding the Rate of Variation of the Moon's Motion at any instant. By Lieut. Raper.

Since the velocity at any instant is the limiting ratio of the increment of y (the right ascension, for instance) to that of t, the time, it is the value of $\frac{dy}{dt}$ obtained from the series expressing the right ascension by differences; and therefore finding the velocity amounts to drawing a tangent to a curve, whose ordinates proceed by differences, stopping at the mean second difference as near enough. It appears, hence, that when the time is near 6^h the change in Æ, &c., is a proportional part of the difference for 12^h; that the velocity so computed per minute or second holds good for 12^m of time at least, in all cases, without introducing an

error of 0″.1 —; and that the error varies nearly as the square of the time.

VIII. On the Determination of the Solar Parallax, from Observations of the Transit of Venus, June 3, 1769. A posthumous work of Don Joseph Joachim de Ferrer; followed by a Summary by Don Joseph Sanchez Cerquero. Communicated by Sir James South.

Don J. J. Ferrer has collected all the memoirs which appeared on this subject, and has entered into a particular discussion of each. He calculated the differences of longitude between the places of observation by the eclipse of the sun and transit of *Mercury* of the same year. The mean equatorial parallax deduced from the whole he considers as 8″,58, without the possibility of a greater uncertainty than 0″,03. He concludes with a table of longitude deduced from the different observations. There is also a table of the observed differences in time between the coincidences of the limbs and the formation or breaking of the luminous thread, which, by a mean of 20 observations, is 34″,1, but with great variations.

The results obtained by Euler, Hornsby, Pingré, Du Sejour, Lexell, La Lande, and Maskelyne, are so different as to leave the parallax uncertain within 0,″35. M. Ferrer shews that these "differences arise sometimes from errors committed by them in their calculations, sometimes from employing observations the inaccuracy of which would have been readily discovered if all had been calculated, and sometimes from confounding in the observations the moments of internal contact with those of the formation or breaking of the luminous thread."

"The complete duration of the transit of *Venus* was observed in the following places:—Cape Wardhus, Kola, Cajaneburgh, Otaité, Fort Prince of Wales, on the North-west coast of Hudson's Bay, and at St. Joseph and St. Anne, in California.

"The *ingress* of the planet was seen in almost all the observatories of Europe, and the *egress* at St. Petersburg, Takutsk, Manilla, Batavia, Pekin, Gurief, Orska, and Oremburg."

In the discussion of the particular observations there is not much that can be usefully separated from the rest. Subjoined is the criticism of M. Ferrer on the observations and deductions of Père Hell, at Cape Wardhus.

"It is known that the Père Hell did not publish his observations till six months after they were made, and that he defended himself from the charges brought against him by astronomers of the time, by saying, that as he had made the observations under the patronage of the King of Denmark, he thought himself obliged to offer them to his majesty previously. However that may be, it is certain that some persons rejected these observations, while others adopted them as very exact.

"I have remarked, that the end of the solar eclipse, which is asserted to have been very accurately observed at Wardhus, is different from that which is deduced from the formation of the luminous thread at the ingress. It also appears from a mean of 20 results, which I shall insert hereafter, that the difference of time

between the coincidences of the limbs and the formation or rupture of the luminous thread is $34^s,1$, while, from the preceding observations, it would appear to be $8^s,3$ at the ingress and 9^s at the egress. Besides this, another contradiction may be noted in what the Père Hell says relative to the interior contact at the egress. In effect, this astronomer says, ' that he observed a black drop or spot, " gutta nigra," formed between the dark limb of *Venus* and the bright limb of the sun at $15^h\ 27^m\ 24^s,6$; at $15^h\ 27^m\ 30^s,6$ this drop momentarily disappeared, and, as it were, diffused itself, and the limbs of the sun and *Venus* joined together, and so formed the internal optical contact at $15^h\ 27^m\ 35^s,6$. This internal contact was so instantaneous, that, in the opinion of the Père Hell, it was exact to a second of time.'

" By this relation it would seem that the observation deemed important by the Père Hell was the coincidence of the limbs, which he calls the optical contact, and not the formation of the drop. The other observers at Wardhus contented themselves with observing this optical contact, without determining when the luminous thread was broken.

" The incomprehensible part of this account is, how, after the drop was formed at the egress, it should so suddenly disappear, and the contact of the limbs take place without the uncertainty of a single second. That which is truly instantaneous is the formation or breaking of the luminous thread when the drop was formed, which does not disappear in the coincidence of the limbs, whence the observations of the contacts are more doubtful than the formation or breaking of the luminous thread.

" It should also be observed, that in the dissertation of the Père Hell upon the sun's parallax, he adopted the moment of the formation of the drop, $15^h\ 27^m\ 24^s,6$, for that of the optical contact, having forgotten what he had said in his first dissertation."

IX. An Ephemeris of Encke's Comet for the Southern Hemisphere. By Professor Encke. Communicated by Lieutenant W. S. Stratford. This Ephemeris is founded on the subjoined elements, which are deemed more accurate than those inserted in the Supplement to the *Nautical Almanac* for 1832. It contains, for every day, from May 18,3 to August 16,3, 1832, the right ascension and declination, to the tenth of a second, with the horary motions to the hundredth of a second, and the log. distance of the comet from the earth to five places of decimals. Professor Encke also gives the corrections for the perturbations for every fifteenth day; and corrections for aberration and nutation, together with the log. of the radius vector, for every fifth day.

Elements.

Epoch, 1832, May 4,0. Paris Mean Time.		
Mean Anomaly.....	0° 0′ 20″,86	
Mean Diurnal Motion..... ..	1071,32651	
Long. of the Perihelion	157° 21′ 32″,2	from Mean Equinox
——— Node	334 32 4,1	of May 4.
Inclination	13 22 12,3	
Angle of Excentricity	57 43 17,0	
Log. of the Semi-axis major..	0·3467232	

X. A List of Stars observed with the Moon at the Royal Observatory, Greenwich, in the month of April, 1832.

		Transit Clock. h m s	Daily Rate of the Clock.
April 8.	3 Cancri	7 51 53,50	+ 0s,26
	☽ 1 L.	7 59 56,36	
	θ Cancri	8 22 46,76	
	δ Cancri	8 35 52,00	
9.	θ Cancri	8 22 44,86	+ 0s,14
	δ Cancri	8 35 52,06	
	☽ 1 L.	9 0 43,92	
	7 Leonis	9 27 26,26	
10.	7 Leonis	9 27 26,28	+ 0s,13
	☽ 1 L.	9 59 9,42	
11.	ε Leonis	10 24 42,44	− 0s,21
	ζ Leonis	10 41 10,30	
	☽ 1 L.	10 55 4,14	
	ν Virginis	11 37 58,50	
April 13.	τ Virginis	12 1 49,80	− 0s,20
	(142) Virginis	12 30 33,40	
	☽ 1 L.	12 40 50,26	
	k^4 Virginis	12 56 0,38	
14.	☽ 1 L.	13 31 53,76	− 0s,24
	88 Virginis	13 40 15,96	
	94 Virginis	13 58 9,34	

XI. Observations of the Moon and Moon-culminating Stars, made at Cambridge Observatory, in the month of April, 1832. Long. 23s,54 E., Lat. 52° 12′ 50″.

Day.	Names.	Clock time of Transit. h m s	Clock's losing rate. s
April 8.	3 Cancri	7 50 16,94	1,41
	Moon 1 L.	7 58 18,87	
	θ Cancri	8 21 8,32	
	δ Cancri	8 34 15,59	
9.	δ Cancri	8 34 14,28	1,29
	Moon 1 L.	8 59 5,12	
	7 Leonis	9 25 48,34	
11.	ε Leonis	10 23 2,19	1,21
	ζ Leonis	10 39 30,02	
	Moon 1 L.	10 53 22,97	
13.	τ Virginis	12 0 7,46	1,27
	(142) Virginis	12 28 51,09	
	Moon 1 L.	12 39 7,03	

1832. March 8. Disappearance of *Aldebaran* at the moon's dark limb, at $11^h\ 9^m\ 20^s,65$ Cambridge sidereal time.

J. Moyes, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *June* 8, 1832. No. 14.

THE following communications were read:—

I. On the transit of *Mercury* of the 5th of May 1832. By the Rev. J. Fisher. Communicated by Captain Beaufort.

This observation was made near the landing-place of Pampulha, at Lisbon, in latitude 38° 42′ 30″ N., longitude 36^m 40^s W., with a 45-inch refractor, by Dollond, of 3¾ inches aperture.

"A series of zenith distances of each of the sun's limbs was taken immediately before the contact of *Mercury* with the sun's limb in the morning, and another series at the conclusion of the transit in the afternoon, both of which agreed in assigning the same error to the chronometer.

		Mean solar time. d h m s	Apparent time. d h m s
Ingress	Exterior	4 20 22 46	4 20 26 15
	Centre	4 20 24 55	4 20 28 24
	Interior	4 20 26 4	4 20 29 33
Egress	Interior	5 3 8 56	5 3 12 26
	Centre	5 3 10 30	5 3 14 0
	Exterior	5 3 12 16	5 3 15 46

The first exterior contact was given by estimation, the planet having made a slight impression on the moon's limb before the observation began.

II. Observations of the Occultation of *Saturn* of May 8, 1832.

1. Mr. Lawson and another observed this phenomenon at Hereford, latitude 52° 3′ 16″ N., longitude 2° 42′ 20″ W., with a 5-feet achromatic, by Dollond, power 150, and a 44-inch achromatic, power 70. The planet disappeared gradually, and the convex edge of the moon did not appear broken or altered. The part of the ring which disappeared last was as bright and well-defined as a brilliant star of the 5th magnitude, and was longer in disappearing than the rate of motion of the other parts gave reason to expect. At the emersion, the planet appeared small, dull, and gauzy. At three or four diameters' distance from the moon it appeared as usual (as to size), but the colour was a yellowish-green, somewhat like that of dull, or what is technically called "mat," gold. The whole time of the occultation was 1^h 0^m 52^s.

2. Mr. Holehouse observed the same at Islington, with a 7-feet achromatic, power 100. When the body of the planet was nearly hid by the moon, a faint concussion of light appeared on the moon's dark limb. At emersion, the planet was of a leaden hue, and apparently diminished in size. Mr. Holehouse thinks the diminution and change of colour lasted until *Saturn* was 15 minutes distant from the moon.

3. Mr. Snow observed the same occultation. The times, &c. are as follow:

Immersion at Moon's dark limb.

	True sidereal time. h	m	s	
Saturn's first limb	12	12	14,6	
Saturn bisected *apparently*	12	12	36,5	
Saturn's second limb	12	13	3,5	
Second edge of *Saturn's* ring	12	13	33,5	

Emersion at Moon's bright limb.

First edge of *Saturn's* ring	13	12	31,5	
Saturn's second limb	13	12	58,5	
Second edge of *Saturn's* ring	13	13	15,5	

From the above observations.

Ingress of *Saturn's* centre	12	12	39	pretty certain.
Egress of do.	13	12	53	uncertain to about 1s.

Moon's $\mathcal{R}$ on the meridian the same evening, $10^h\,39^m\,0^s,06$ well observed.

"There was not the slightest appearance of any projection at either the immersion or emersion. Though the whole phenomenon was seen through thin creamy clouds, the arc of the moon's dark limb was quite clearly defined on the disk of *Saturn* at the immersion; and at the emersion, *Saturn* appeared quite distinct from the moon's bright limb, and so much darker, that it was difficult to observe its egress. There was a very marked difference, in this respect, between the occultation of *Jupiter* that happened last summer, and this occultation of *Saturn; Jupiter*, at his immersion, appearing nearly as bright as the moon.

"The telescope used was a 42-inch refractor. For the immersion, a power of 180, adjusted to *Saturn;* for the emersion, a power of 120, adjusted to the moon's bright limb, which, however, was very tremulous and coloured. The evening, altogether, was wild and unfavourable."

III. Observations of the Solstices from December 1829 to December 1831; and Observations of Moon-culminating Stars during the year 1831; made at the Hon. East India Company's Observatory. By Lieut. Johnson. Communicated by Captain Beaufort.

This is the second set of observations forwarded by Mr. Johnson. (See *Monthly Notice* for March.) The solstices were observed with a 4-feet mural circle, having 6 microscopes. The index error was found by Mr. Pond's method of differences between the observed places of the principal stars, and then given in the *Nautical Almanac*. The other reductions are from Dr. Pearson's Tables, altering the coefficient of lunar nutation from 9″,648 to 9″,20. Dr. Young's Tables of Refraction were used.

The latitude, 16° 55′ 24″ N., is the result of several observations, direct and by reflexion, of the principal stars in the Greenwich Catalogue. The longitude has hitherto been assumed $22^m\,30^s$ W., but a mean of three observations of moon-culminating stars with corre-

sponding observations at Greenwich, gives $22^m\ 57^s,5$ W., which corresponds very nearly with that given by Capt. Owen. The mean obliquity at the different solstices is as follows:

December 1829, 1830, 1831,	St. Helena.....	23° 27′ 38″,96
	Greenwich.....	40 ,19
	Diff.	−1 ,23
June 1830, 1831,	St. Helena.....	23° 27′ 43 ,65
	Greenwich.....	42 ,56
	Diff.	1 ,09

If Bradley's Refractions had been used, the obliquity at the northern solstice would have been reduced about 0″,65, and that at the southern, 0″,14.

IV. On the Calculation of the Geographical Longitude and Latitude of a place whose Geodesic Distance from the Meridian and Perpendicular of another place is given, the Earth being considered as a Spheroid. By Baron Zach.

The formula used by Baron Zach is one given by M. Oriani in the year 1805, and published in the *Correspondance Astronomique*, Vol. XI. p. 550. It was used by Captain Kater, as more convenient than any other. It is as follows:

Let a, b, and e be respectively the semi-major and semi-minor axes and the excentricity of the terrestrial spheroid: M the linear distance of the point whose longitude and latitude are required from the *perpendicular* of the given place: P the linear distance of the first place from the *meridian* of the second: m and p the two last-mentioned distances in seconds: L the latitude of the given place: λ that of the intersection of the line on which P was measured with the meridian of the given place: φ and u the latitude and longitude required: ψ, a subsidiary angle. Then

$$\text{I.}\quad \lambda = \mathrm{L} \pm m\left[1 - \frac{3}{2}e^2 + 3e\cos^2\left(\mathrm{L} \pm \frac{m}{2}\right)\right]$$

$$\text{II.}\quad \psi = p\left[1 - \frac{3}{4}e + 2e\cos^2\lambda\right]$$

$$\text{III.}\quad \sin\varphi = \sin\lambda\cos\psi.$$

$$\text{IV.}\quad \tan u = \frac{\tan\psi}{\cos\lambda}\left[1 - e\cos^2\lambda\right].$$

M. Zach has adopted a *mean spheroid*, as recommended by M. Gauss; that is, one which shall most nearly represent the various measures, without being deduced from any one in particular. By applying the method of least squares to a number of latitudes, as determined both by astronomical observation and geodesical measurement, M. Schmidt has found the following elements: $a = 3271852{,}32$ toises; $b = 3260853{,}70$; length of a mean degree $= 57008{,}655$ toises $= 364547{,}1$ English feet; the compression $\left(\frac{a-b}{a}\right) = \frac{1}{297{,}479}$, and $e = \cdot 00335617$. Hence (M and P being in feet),

$$m = \frac{3600}{364547{,}1}\mathrm{M}, \text{ or } \log m = \log \mathrm{M} + 7\cdot 9945489$$

$$p = \frac{3600}{364547{,}1}\mathrm{P}, \text{ or } \log p = \log \mathrm{P} + 7\cdot 9945489$$

The factors in I., II., and IV., which are contained in square brackets [ ], being functions of e and $L \pm \frac{m}{2}$, have been calculated by M. Zach for the above-mentioned value of e, and for every degree of latitude up to 70°. The following modification of formulæ III. and IV. is also given, as one which may be used with advantage, ψ being in seconds, and the logarithms of ϱ and r being 4·3845549 and 8·8940285.

$$\varphi = \lambda - \varrho\, \psi^2 \tan \lambda,$$
$$u = \psi \sec.\lambda\, [1 - e \cos^2 \lambda]\, (1 - r\, \psi^2 \tan^2 \lambda\, [1 - e \cos^2 \lambda]^2).$$

M. Zach has also given a table of the correction which must be applied to m, in order to give the second term of (I.), for every ten minutes of latitude from $L \pm \frac{m}{2} = 50°$ to $L \pm \frac{m}{2} = 60°$, the known place being the Observatory of Greenwich. This table is intended to facilitate the application of the method to all measurements taken in the United Kingdom.

M. Zach applies his method to two examples: 1. The determination of the position of Calais with respect to Greenwich: 2. That of Fort Mont-jouy, near Barcelona, with respect to Dunkirk, involving the longest distance measured in the French survey (*Base du Système Métrique*, Vol. III., p. 268). The differences in latitude and longitude between the result of the present method and that of Captain Kater, in the first example, and the result of astronomical observation in the second, are 0″,11, 0″,43, and 0″,1, 0″,28.

V. Mean Right Ascension of Fifty-five Unknown Stars, observed in 1831, with a Transit Instrument of twenty inches focus, and a Sidereal Chronometer beating half seconds; also Occultations observed in the month of March 1832. By Mr. Snow.

VI. Fifth Catalogue of Double Stars observed at Slough in the years 1830 and 1831, with the 20-feet Reflector, and reduced to the epoch 1830·0. By Sir J. W. F. Herschel, K.G.H.

VII. Observed Occultation of Aldebaran. By Mr. Rothwell. Communicated by Mr. Tulley.

Mr. Rothwell observed the occultation of *Aldebaran* on the 8th of February, and saw no projection or change of colour whatever. He also observed a star which came so nearly in contact with the moon as to induce him to expect an occultation, without seeing any remarkable circumstance.

VIII. Ephemeris of Encke's Comet, for the Southern Hemisphere. From Professor Encke.

The elements given by Professor Encke are as follow.

Epoch, 1832, May 4,0. Paris Mean Time.				
Mean Anomaly	0°	0′	20″,86	
Mean Daily Motion	1071″,32651			
Longitude of the Perihelion	157°	21′	32″,2	from mean equinox of May 4,0.
——— Node	334	32	4,1	
Inclination	13	22	12,3	
Angle of excentricity	57	43	17,0	
Log. Semi-major axis	0·3467232			

IX. Stars observed with the Moon, at the Royal Observatory, Greenwich, in May 1832.

		Transit Clock. h m s	Daily Rate.
May 8.	ε Leonis	10 24 29,00	
	☽ 1 L.	10 38 22,77	− 0ˢ,97
	(12) Leonis	11 5 49,34	
9.	☽ 1 L.	11 31 55,53	− 0ˢ,88
	δ Virginis	11 51 51,80	
10.	δ Virginis	11 51 50,70	
	☽ 1 L.	12 23 28,62	− 0ˢ,78
	γ^1 Virginis	12 33 39,54	
13.	2 Libræ	14 14 52,22	
	(127) ——	14 28 32,54	− 0ˢ,72
	☽ 1 L.	14 53 41,20	
	γ Libræ	15 26 36,92	
15.	χ Ophiuchi	16 17 44,48	− 0ˢ,88
	☽ 2 L.	16 37 49,06	

X. After the reading of the preceding communications, Mr. Sheepshanks made some remarks upon the mode of adjusting the transit instrument, and proceeded to describe minutely the various corrections requisite for obtaining correct results, illustrating his statement from various transit instruments furnished for the occasion by Messrs. Troughton and Simms.

J. Moyes, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

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THE following communications were read :—

I. Observations of Biela's Comet, by Sir J. F. W. Herschel.

" The moon being sufficiently removed from the presumed place of this interesting object, and the promising aspect of the evening of the 22d September last holding out hopes of detecting it by the powerful light of the 20-feet reflector, I directed that instrument, with a newly-polished mirror, to a point of the heavens determined by taking a mean of the right ascensions and declinations, calculated by M. Santini from his own and from Damoiseau's elements. A haze, however, which, as the evening advanced, rapidly increased to a decided cloud, disappointed my expectations for that night; but on the following evening, the sky being perfectly clear, after sweeping to and fro for about five minutes over the place similarly calculated for the time of observation, I had the satisfaction of seeing the comet enter the field as a conspicuous nebula of about $2\frac{1}{2}'$ or $3'$ in diameter, and of such a degree of brightness as would entitle it to a place in my father's first class, or 'bright nebulæ.' It had no tail; and though its rate of increase of density towards the centre was rather more rapid and decided than about the circumference, yet there was nothing in the least entitled to the name of a nucleus. As no nebula exists in that part of the heavens which could be confounded with an object of this description, it was of course immediately recognised as the object sought: but had I entertained any doubt of its identity, it would have been dispelled by its motion, which, during an hour and a half, or thereabouts, that I kept it in view, was very considerable. At the commencement of my observation, it formed an irregular trapezium with three pretty bright stars, A, B, C; with two of which I measured its angles of position, and, on repeating the measures after a short interval, found them sensibly altered. The change of place speedily became remarkable to the eye, and was such as to carry the comet towards two or three other pretty bright stars, D, E, in a distant part of the field. In approaching these, it passed directly over a small cluster or knot of minute stars, of the 16th or 17th magnitude, which occupied a space about a minute or two in diameter; and, when on the cluster, it presented the appearance of a nebula resolvable, and partly resolved, into stars, the stars of the cluster being visible through the comet.

" A more striking proof could not have been offered of the extreme translucency of the matter of which this comet consists.

The most trifling fog would have entirely effaced this group of stars; yet they continued visible through a thickness of the cometic matter, which, calculating from its distance and apparent diameter, must have exceeded 50,000 miles, at least towards its central parts. That any star of the cluster was *centrally* covered is, indeed, more than I can assert; but the general bulk of the comet may certainly be said to have passed centrally *over the group*.

"The reflector being at that time in a great measure dismantled, for the purpose of making some changes in the sweeping apparatus, I was unable to determine, as I could have wished, the place of the comet by an extra-meridian sweep; I was, therefore, obliged to have recourse to the 7-feet equatorial (aperture 5 inches), with which, at best, I could only hope to procure an approximate place; and from my knowledge of its comparative inefficiency in shewing nebulæ, I had very slender expectation of being able to see it at all. However, by carefully noting in the finder of the large instrument the exact *locality* of the spot with respect to the stars θ, ν, and τ *Aurigæ*, I was enabled, with no great difficulty, to find the telescopic constellation consisting of the stars A, B, C, D, E, with which I had compared the comet in the reflector; and, after very long and careful attention in a field totally dark, and without the smallest light in the observatory, I succeeded in obtaining a sight of the comet in the place where, from its motion during the interval, I expected to find it. Under such circumstances, any determination of its place must be exceedingly vague; and, in fact, on reducing three comparisons which I obtained, directly and indirectly, of its place with that of θ *Aurigæ*, it became evident that in one of them I must have mistaken a retinal spectrum produced by nervous excitement, for the comet. For their results when reduced gave as follows, (calling α and δ the right ascension and declination of θ *Aurigæ*, and α' δ' those of the comet):

By the first comparison...	$\alpha' = \alpha - 8^m\ 4^s$	$\delta' = \delta - 53'\ 30''$
..... second....	$\alpha' = \alpha - 9\ 9$	$\delta' = \delta - 59\ 0$
..... third.....	$\alpha' = \alpha - 7\ 51$	$\delta' = \delta - 55\ 48$

The sidereal times of observation (corrected for the clock's error) being respectively $3^h\ 53^m\ 41^s{,}5$, $4^h\ 32^m\ 40^s{,}5$, $4^h\ 51^m\ 36^s{,}5$. The second of these results must evidently be rejected for the reason above mentioned; whence the mean of the two others gives, for $4^h\ 25^m\ 29^s{,}5$ sid. time,

$$\alpha' = \alpha - 7^m\ 57^s{,}5 \ldots\ldots \delta' = \delta - 54'\ 39''.*$$

"At $4^h\ 51^m\ 36^s{,}5$, sid. time, the comet was compared with a small double star, whose approximate place for 1830·0 was found, by comparison with θ *Aurigæ*, to be

$$R\ 5^h\ 40^m\ 54^s{,}5;\ \text{Decl.} + 36°\ 13'\ 31''.$$

The stars composing this double star are about the 8th and 9th

* The mean place of θ *Aurigæ*, brought up to Jan. 1, 1832, by the precession assigned in the Astronomical Society's Catalogue, is

$$R\ 5^h\ 48^m\ 15^s{,}6;\ \text{Decl.} + 37°\ 11'\ 33''.$$

magnitudes; their distance, roughly taken, about 65 parts of the micrometer = 15″; and their angle of position 13° 20′ *sf* = 103° 20′. This description will enable any observer easily to identify and re-observe the double star in question. The comet, at the time above stated, *preceded* the double star 38 seconds of time, and was found, by a micrometric estimation (for I cannot call it a measure) to be about 550 parts = 2′ 12″ *North* of it.

"On the next night, I again observed the comet with the 20-feet reflector, and again found it without the least difficulty. It was very little, if at all, perceptibly brighter or larger than the preceding night; but had entirely deserted its former place, and was now near a single, pretty bright star, of fully the 10th magnitude, insulated in the field, and easily identifiable. The approximate place of this star for 1830·0 I found, by comparison with θ by the equatorial, to be $\mathcal{R}$ $5^h\ 45^m\ 18^s,0$; Decl. + 36° 13′ 31″.

"I procured, through the intervention of this star, two indirect comparisons of the comet with θ *Aurigæ;* in both of which I was, however, obliged to *estimate* the difference of declinations of the comet and star at 2′, by reason of the excessive feebleness of the former, which rendered all measurement impracticable. I also compared it twice *directly* with θ; but of these comparisons, one when reduced, proved to have been an illusion of the kind above mentioned; I therefore suppress its result. Those of the others were as follow:—

By intervention of the small star, 1st comparison	$t = 2^h\ 1^m\ 4^s$ sid. time;	$\alpha' = \alpha - 2^m\ 28,5$;	$\delta' = \delta - 1°\ 0'\ 0''$
By ditto, 2d ditto	$t = 3\ 1\ 4$	$\alpha' = \alpha - 2\ 14,5$;	$\delta' = \delta - 1\ 0\ 0$
By direct comparison with θ	$t = 2\ 30\ 46$	$\alpha' = \alpha - 2\ 25,0$;	$\delta' = \delta - 1\ 1\ 0$
Mean	$t = 2\ 30\ 58$	$\alpha' = \alpha - 2\ 23,5$;	$\delta' = \delta - 1\ 0\ 20$

"The following night it proved cloudy, and my attention being distracted to other objects, I have not since pursued the comet; nor should I have thought it worth while to communicate observations confessedly so imperfect as the present, to the Society, but for the high interest attaching to the object, as well as for an impression left on my mind, by the excessive feebleness of its light as seen in the equatorial, that it may have escaped the notice of most observers at this early period of its appearance, for want of light, as I am certain I could never have found it by any degree of attention with that instrument, had not its precise place been given by the 20-feet reflector.

"I know not whether I may be pardoned the mention of a conjecture in this place, as to the origin of a very striking phenomenon in the history of comets, which seems to have been satisfactorily established, at least in some instances, by positive observations; which is, their dilatation of volume as they recede from, and concentration within a smaller compass as they approach, the sun. This phenomenon has been attempted to be accounted for by a supposed *pressure* of the ether, whose density is assumed to

increase in the sun's vicinity. But, not to mention that the effect would not follow from the cause without supposing the matter of the comet impermeable to the ether (as a sponge is not compressed by lowering it in water unless enclosed in a water-tight case), it appears to me that the phenomenon is explicable on a much less gratuitous supposition; viz. that of the extremely feeble attractive force by which the matter of a comet must be held together, owing to the probable extreme minuteness of its mass. *Cohesion* can hardly be supposed to exist in a gaseous or nebulous body of such tenuity; so that the only bond of union between its molecules must be their feeble gravitation to each other, which is hardly more than mere juxtaposition in space. Hence we must regard each molecule as constituting almost a separate, independent projectile, describing its own parabola about the sun. Now, the interval between two or more parabolas described about a common focus, and having their axes coincident, is a minimum at the perihelion, and increases as we recede from it, in a ratio easily calculable. The volume, on this view of the subject, ought to increase in the sesquiplicate ratio of the radius vector. The observations of Encke's comet, cited by M. Arago, indicate, no doubt, a much more rapid law of increase; but, not to mention the difficulty of obtaining any positive measures of a body so ill-defined as a comet, the circumstances under which the observations must necessarily be made have a powerful tendency to exaggerate the effect; since, in proportion as a comet recedes from the sun, it is continually seen projected upon a darker and darker part of the heavens as it emerges from the twilight; in consequence of which, exterior strata of the nebulosity become perceptible which were incapable of affecting the eye before. Those who are at all conversant with the observation of nebulæ, will not fail to have remarked the rapid rate of the obliteration produced by very trifling degrees of illumination, natural or artificial, of the field of view. Now, it is precisely on comets or nebulæ, whose condensation towards the centre is feeble and which (like the comets of Encke and Biela) have no nuclei, that this action is most powerful, and its effect most extensive. I would not, however, be understood by any means to deny the reality of a more rapid law of variation than that which results from the foregoing consideration. If it subsist, of course we must look out for another explanation. At all events, the conclusion we have arrived at, regarded as a geometrical result, is not devoid of a certain degree of interest; and the cause I have assigned, having the character of a *vera causa*, cannot be excluded from some share in the production of the observed effect, even should it not be found sufficient to account for the whole.

"There is, however, another way in which the apparent dimensions of a comet may be conceived to vary with its proximity to the sun, while its real volume may remain unaltered, or even undergo a contrary change. The nebulous portion of the comet, or that which reflects the sun's rays, is not improbably of the nature of a fog, *i. e.* a collection of discrete particles of a vaporisable fluid floating in a

transparent medium. Now, as these molecules, during the comet's approach to the sun, absorb its rays and become heated, a portion of them will be constantly passing from the liquid and visible to the gaseous and invisible state. As this change must commence from without and be propagated inwards, the effect will be a diminution of the comet's visible bulk. On the other hand, in its recess from the sun, it will part with the heat thus acquired by radiation, which, in conformity with the general analogy of radiant caloric, will take place chiefly from the unevaporated or nebulous mass within, whose dimensions will therefore begin and continue to increase by the precipitation immediately above it of fresh nebulous matter, just as we see fogs in cold still nights forming on the surface of the ground, and gradually extending upwards as the heat near the surface is dissipated. The comet will thus appear to enlarge rapidly in its visible dimensions, while the real *volume* is in fact slowly shrinking by the general abstraction of heat from the mass.

"This process might go on in the entire absence of any solid or fluid nucleus; but supposing such a nucleus to exist, and to have acquired a considerable increase of temperature in the vicinity of the sun, evaporation from its surface would afford a constant and copious supply of vapour, which, rising into its atmosphere and condensing at its exterior parts, would tend yet more to dilate the visible limits of the nebula. Some such process would naturally enough account for the appearances which have been noticed in the heads of certain comets, where the stratum, void of nebula, has been observed interposed, as it were, between the denser portion of the head or nucleus and the coma.* It is analogous to the meteorological phenomenon of a definite *vapour plane*, so commonly observed; and, in certain cases, may admit of two or more alternations of nebula and clear atmosphere.

"If, however, after all, we should prefer to call in an ethereal medium surrounding the sun, as the sole or partial cause of the remarkable phenomenon in question, it will not be necessary to have recourse to the idea of condensation arising from its mechanical pressure, which, as we have seen, is repugnant to what we know of the mode of propagation of pressure in fluids. A less repugnant explanation offers itself in the presumable habitudes of the ethereal fluid with respect to heat. Fourier has rendered it not improbable, that the region in which the earth circulates has *a temperature* of its own, greatly superior to what may be presumed to be the *absolute* zero, and even to some artificial degrees of cold; and, in my *Essay on the Study of Natural Philosophy*,† (p. 157), I have shewn, I think satisfactorily, that if this be the case, such temperature cannot be due simply to the radiation of the stars, but must arise from some other cause, such as the contact of an ether possessing itself a determinate temperature, and tending, like all known fluids, to

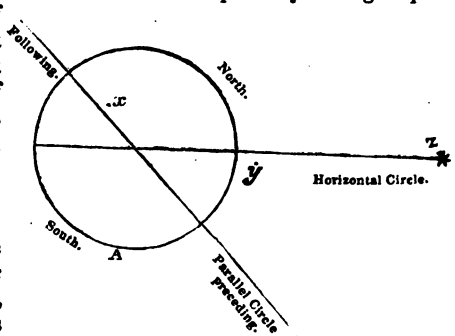
* See my father's observations on the comet of 1811.

† See also my paper on the astronomical causes of geological phenomena.

communicate this temperature to bodies immersed in it. Now, if we suppose the temperature of the ether to increase as we approach the sun,—which seems a natural, and, indeed, a necessary consequence of regarding it as endued with the ordinary relations of fluids to heat,—we are furnished with an obvious explanation of the phenomenon in question. A body of such extreme tenuity as a comet may be presumed to take very readily the temperature of the ether in which it is plunged; and the vicissitudes of warmth and cold thus experienced may alternately convert into transparent vapour, and re-precipitate the nebulous substance, just as we see an increase of atmospheric temperature dissipate a fog, not by abstracting or annihilating its aqueous particles, but by causing them to assume the elastic and transparent state which they lose, and again appear in fog when the temperature sinks."

In a subsequent letter to Mr. Baily, Sir J. Herschel gives an account of a further observation obtained on the morning of the 4th November. The following is an extract:—

"After watching in vain for an opportunity of renewing my observations of the comet on the mornings of the 2d and 3d instant (Nov.), the cloudy state of the sky on both mornings from 2 A.M. till day-break precluding all possibility of observing it, I succeeded, on the morning of the 4th, in getting a very satisfactory observation. Having set the 20-feet reflector on the spot indicated by Mr. Henderson's Ephemeris, I had hardly made two or three azimuthal sweeps of the tube to and fro, when it made its appearance in the field of view as a large and very bright nebula. Judging of its light as compared with that of two nebulæ of the 2d class which occurred in the first azimuthal sweep, I should say that its impression on the eye was at least 100 times that of one of the nebulæ. I judged its diameter to be full 4′. The condensation towards the middle was considerable, and the centre itself was occupied by a bright point about equal to a star of the 13th magnitude. It had no decided tail, but only a feeble trace of some extension of its nebulosity in a direction about 40° N.P. from the parallel.



"At $5^h\ 53^m\ 21^s$ sidereal time at Slough, the comet preceded a star x of the 10th magnitude, $11^s{\cdot}0$ of time, and its position from the star, taken by the position-micrometer used in my observations of double stars (for which its own light afforded ample illumination), was $274^{\circ}{\cdot}0$, so that the comet's centre was at that time $11''{\cdot}4$ north of the star.

"A large star of 5·6 mag., which proved to be *z Leonis* (Fl. 43), preceded the comet about a minute and a quarter of time, by rough estimation, and was judged to be about 13′ or 14′ to the south of it; but as my field of view would not take in both objects, I was about to have recourse to the equatorial, when it clouded. At this time the comet was rapidly approaching the star *x*, which had even begun to be involved in the extreme borders of its nebulosity. Its path, as nearly as I could judge, would have carried its centre about 40″ south of the star.

"The next night (Nov. 4–5) was unfavourable, clouds persisting obstinately in resting on and about the comet's place, while the horizon elsewhere was generally clear. However, as a star of the 10th magnitude is visible in my reflector through a pretty thick cloud, I succeeded in ascertaining the place of the star *x* of last night's observation with sufficient exactness to secure its identification, should any one be inclined to re-observe it. It follows 43 (*z*) *Leonis* $1^m\,32^s{\cdot}2$ of time, and is about 12′ 47″ north of that star; so that its approximate place for 1832·0 will be Æ $10^h\,15^m\,44^s{\cdot}8$; Decl. + 7° 36′ 23″; which I apprehend to be within 1^s of the truth in Æ, and 1′ in decl.; and hence the approximate place of the comet at the epoch of the preceding night's observation must have been, Æ $10^h\,15^m\,34^s$; Decl. + 7° 36′ 34″. The place for the same epoch, interpolated from Mr. Henderson's Ephemeris, computed from Damoiseau's Elements, is Æ $10^h\,12^m\,30^s$; Decl. + 8° 17′.

"It was not till about 8^h sid. time that the clouds were sufficiently dispersed from the comet's place to allow a view of it. Being then, however, at a much greater altitude than when seen last night, it was proportionally brighter, and was, indeed, a very fine and brilliant object. The trace of a tail or branch in the same direction as last night, though extremely feeble, was now unequivocal, and the central point not to be overlooked. It had not, however, the appearance of a star, but seemed more analogous to the central point in some nebulæ, such as that in *Andromeda*, which is probably only nebula much more condensed than the rest. The comet's diameter could not be estimated under 5′, and I suspected some degree of nebulosity even beyond that limit.

"At $8^h\,8^m\,29^s$ sid. time at Slough, the comet's centre followed a star *w* in the field, almost exactly $1^s{\cdot}5$ north of it, (a good observation). The comet being then allowed to run along the middle wire, so as to traverse a diameter of the field while the star traversed a chord, I found the times occupied to be respectively $57^s{\cdot}5$ and $25^s{\cdot}5$, which gives for their difference of declination 6′ 24″, the comet being south of the star. The star *w* is a conspicuous one, of fully the 9th mag., and there is no other which can be mistaken for it. A star of the 10 mag. precedes it about 20^s of time, and is about 2′½ south of it; but except this there is no other considerable star within *at least* 10′ in all directions. The comet's daily motion (obtained per Ephemeris) may therefore be safely used to identify this star. Admitting, then, that in the interval ($26^h\,15^m$ S.T.) elapsed since the last observation the comet had [illegible]

+ $6^m\ 20^s$ in $\mathcal{R}$, and — 1° 10′ 3″ in decl., we get for the approximate place of the star *w* for 1832·0,

$$\mathcal{R} = 10^h\ 21^m\ 52^s;\ \text{Decl.} + 6^\circ\ 32'\ 55''."$$

Mr. Best presented a diagram of the path of the comet from Oct. 30 to Nov. 14.

II. On a Method of Ascertaining the Rate of Chronometers; especially when a strict examination of their performances is required. By Mr. James Epps, Assistant Secretary of the Society.

For the purpose of obtaining the rate of a mean-time chronometer with the greatest accuracy, Mr. Epps recommends that the comparisons should be made directly with the transit clock by the *coincidence of beats*. The transit clock, in almost every instance, beats seconds of sidereal time, and the ship or box chronometer half seconds of mean solar time. This is the case which will be illustrated; but the principle of the method is the same whatever be the beat of the timekeepers to be compared, provided the one be regulated on sidereal and the other on mean solar time.

It will be generally admitted that the passages of well-known stars over the meridian observed by a transit instrument, either perfectly adjusted, or the errors of which are known and allowed for, afford the most exact and easy means of ascertaining the *absolute error* of a clock; and also that the *rate* of the clock is determined more readily still from a series of such observations. Again, as 6^m of solar are nearly equal to $6^m\ 1^s$ of sidereal time, it is evident that in about 6^m, a solar chronometer will lose two vibrations upon a sidereal clock, and one vibration in 3^m; so that if the two timekeepers beat together at any time, they will at the end of 3^m beat together again, the chronometer having lost $0^s{\cdot}5$ on comparing the readings. This *coincidence* is determinable more or less accurately according to the experience of the observer and the delicacy of his ear. It would be impossible for any one to be mistaken half a minute in this estimation, and such a mistake would not cause an error of $0^s{\cdot}1$ in the actual *comparison;* but it is possible, when all circumstances are favourable, to determine the coincidence within 6^s, which gives the comparison exact to $0^s{\cdot}02$, that is, without sensible error; so that the error and rate of the chronometer may be determined with as much certainty as those of the transit clock itself. It is evidently impossible to compare a chronometer and a clock in the common method with any thing like the same accuracy.

When merely the *rate* of a chronometer is required, and this is commonly the case, there is no need of determining the *absolute error* of either clock or chronometer. The practice adopted by Mr. Epps may be explained as follows: Every day the chronometer is compared with the clock, and the second of each, at which the coincidence is judged most nearly to take place, noted down. The hour and minute of one timekeeper may be set down at leisure. These Mr. Epps arranges in parallel columns. Next day, and suppose at the same time, the comparison is made again, and the results set down under the former in their respective columns. If, then, the

upper quantities be subtracted from the lower, we have the same portion of duration differently expressed; the first of which would be in mean solar, and the latter in sidereal time, if the chronometer and clock went correctly. Hence, after subtracting the acceleration from the sidereal-time interval, or adding the retardation to the mean-time interval, the two should agree, and the difference which is actually found must arise from the *variations* of the timepieces, that is, from the *difference of their rates*. Now, the rate of the transit clock is supposed to be known by observation, and this being applied with the proper sign to the difference just found, the result will be the *rate of the chronometer;* but as the interval will scarcely ever be exactly 24 hours, the difference of the rate must be multiplied by the fraction $\frac{24^h}{\text{interval elapsed}}$ before the application of the daily rate of the clock; which may be done conveniently by the help of a small table. It is evident, also, that when the rates are tolerably close, the only use in noting the hours and minutes is for the purpose of taking out the acceleration correctly, and of obtaining a proper factor to reduce the difference of rates to a 24-hours' rate. Thus the hours and minutes of one of the timekeepers may be neglected, as well as the minutes of the acceleration, &c., which saves a little time and trouble in setting down the comparisons and obtaining the final rate.

III. Observations of the Transit of *Mercury* of May 5, 1832.

1. M. Quetelet, director of the observatory of Brussels, states that the clouds prevented his observing the ingress. The times of egress were as follow, in which allowance has been made for the rate of the chronometer. The telescope used was a reflector with a power of 90:

	d	h	m	s	
Meridian transit of *Mercury* ... May	4	23	59	55,2	Mean time.
Internal contact at egress	5	4	2	52	
External do		4	6	1	

2. Mr. Henderson, astronomer at the Cape of Good Hope, made the following observation. The external contact at ingress was obtained by estimation, *Mercury* having been first seen on the sun at $22^h\ 16^m\ 2^s$:

	d	h	m	s	
External contact at ingress, ... May	4	22	15	56	Mean time.
Internal do		22	19	12	
Internal contact at egress	5	4	58	25	

It was impossible to observe the external contact at ingress, owing to the undulation of the sun's limb, which was then little more than one degree above the horizon.

3. Extract of a letter from Captain Bayfield, R.N. to Captain W. H. Smyth, R.N.

"The transit of Mercury which took place on the 5th of last month, commenced before day-light; but I observed its termination as follows:

Saturday, May 5 11^h *civil*; or May 24 23^h, *astronomical* time.

	h	m	s	
Egress of ☿'s first limb	11	5	33,4	Apparent
..... second limb ...	11	9	2,4	time, A.M.

"The observation was made with one of Jones's 3½ feet achromatic refractors. The weather was tolerably clear, and the time well determined by numerous equal altitudes, with a large and excellent instrument, and an artificial horizon, on the same day. Position of the place of observation, latitude 46° 48′ 50″ N.; longitude 71° 16′ W."

4. Extract of a letter from Captain R. Owen, R.N. to Captain Beaufort, R. N.

		d	h	m	s	
Internal contact at egress ...	May	4	22	49	49	Mean time.
External do.....				53	4	
Flag-staff, Crooked Island	Latitude...		22°	47′	20″	N.
	Longitude		74	18	0	W.

Power of telescope, 120.

5. Observation by Captain Belcher, R.N. at Cavalho Island, Bijoogas.

		h	m	s
Gaining rate of watch on mean time		0	0	3,984
Internal contact at ingress	May 4	9	9	34,2
Do. egress	5	3	50	26,5
External contact at egress			53	52,0

Instrument, reflecting telescope G 20, indifferent, vibration excessive.

The internal egress observed by Lieutenant Kellet, with a powerful refracting telescope of 42 inches, corresponded with the above.

6. Extract of a letter from M. Cacciatore to the Foreign Secretary.

"The transit of Mercury of May 5 was fortunately observed here. The day was fine; but some slight clouds made the sun's limb undulate during the egress.

	Sidereal.			Mean.		
	h	m	s	h	m	s
Internal contact at ingress...	0	49	09,7	21	0	19,8
Do. egress...	7	32	59,8	3	46	59,7
External contact at egress...	7	35	49,9	3	49	49,3

IV. Observations of the Occultation of 104 *m Tauri* of October 13; and of *μ Ceti* of November 7, 1832. By Mr. Snow. Accompanied by the transits of the stars which were used to correct the clock.

1832. October 13. Observed in Saville Row.

Immersion of 104 *m Tauri* (5th mag.) $3^h\ 35^m\ 44^s,7$ sid. time.

The star vanished gradually, as if it had been a small planetary body. Telescope, 45-inch refractor, power 180; adjusted to the star.

1832. November 7. Observed in Saville Row.

Immersion of *μ Ceti* (4th mag.) $23^h\ 35^m\ 41^s,10$ sid. time.

Telescope 45-inch refractor, power 40, adjusted to the star. The star was very sharp and distinct; and although the immersion took place at the moon's dark limb, (the moon wanting about 12 hours of being full), the star did not disappear until it actually reached the enlightened portion of the moon's disk: the star then vanished, *not quite instantaneously*, but suffered no previous diminution of light or change of colour.

V. Observations of the Occultation of *Saturn* of May 8.

1. By Professor Airy and Mr. Maclear, at Cambridge.

Sidereal Time.

Immersion.	AIRY. h	m	s	MACLEAR. h	m	s
First limb of ring touched the Moon	—	—	—	12	12	49,91
First limb of ball touched the Moon	12	13	6,77		13	12,41
Second limb of ball disappeared		14	4,23		14	4,41
Second limb of ring disappeared		14	34,62		14	36,11

The telescope used by Mr. Maclear is more steadily mounted than that used by Professor Airy: in other respects there is little difference between the instruments.

2. By M. Cacciatori, at Palermo.

Immersion.	Sidereal Time. h	m	s	Mean Time. h	m	s
First limb of *Saturn* touched the Moon	13	39	42,9	10	40	45,15
Second limb disappeared.....		40	26,8		41	28,93
Second limb of ring disappeared.....		40	53,7		41	55,76
Emersion.						
Second limb of *Saturn* reappeared	14	44	18,8	11	45	10,48
Second limb of ring reappeared		44	30,8		45	22,45

There was a slight haze in the atmosphere. On emerging, *Saturn* shone faintly for 20^s, and then resumed its usual splendour.

VI. Stars observed with the Moon at the Royal Observatory, Greenwich, in the months of June, July, and August, 1832.

		Time by Transit Clock. h	m	s	Daily Rate. s
June 13.	52 Ophiuchi.....	17	25	17,82	
	D ——.....		33	27,56	—0,85
	(323) Sagitt.....		52	41,50	
	☽ 2 L.....	18	3	38,08	
July 8.	☽ 1 L.....	16	2	23,36	
	χ Ophiuchi		18	6,06	— 0,60
	φ ——		22	20,28	
12.	σ Sagittarii	19	0	32,08	— 0,80
	☽ 2 L.....		31	59,58	
Aug. 7.	(323) Sagittarii	17	52	37,08	
	☽ 1 L.....	18	19	21,70	
	ξ^2 Sagittarii		47	43,34	
8.	ξ^2 Sagittarii	18	47	42,60	
	☽ 1 L	19	11	43,52	
	(138) Sagittarii.....		20	55,86	
	57 —— ...		42	26,32	
11.	ι Capricorni	21	12	51,80	
	(154) Aquarii		21	26,28	
	γ Capricorni....		30	45,08	
	☽ 2 L.....		47	53,94	

VII. Observations of the Transits of the Moon with Moon-culminating Stars, made at Cambridge Observatory in the months of August,* September, and October, 1832.

		Time of Transit. h m s	Clock's losing rate. s
Aug. 7.	μ^1 Sagittarii	18 0 52,13	2,88
	Moon 1 L.	16 28,85	
	ξ^2 Sagittarii	44 51,36	
8.	ξ^2 Sagittarii	18 44 48,48	2,85
	Moon L.	19 8 48,42	
	(138 Sagittarii)	18 1,63	
	57 Sagittarii	39 32,11	
11.	ι Capricorni	21 9 50,15	2,95
	(154) Aquarii	18 24,75	
	γ Capricorni	27 43,51	
	Moon 1 L.	42 44,20	
	Moon 2 L.	44 51,83	
Sept. 4.	Moon 1 L.	18 48 50,34	3,05
	(138) Sagittarii	19 16 43,87	
5.	(138) Sagittarii	19 16 40,91	2,95
	Moon 1 L.	41 3,82	
	π Capricorni	20 13 27,46	
6.	π Capricorni	20 13 24,10	3,02
	Moon 1 L.	32 45,56	
8.	Moon 1 L.	22 13 38,80	3,17
	70 Aquarii	35 15,23	
10.	(126) Aquarii	23 22 21,67	3,01
	Moon 2 L.	53 52,36	
19.	β Geminorum	7 30 2,49	2,93
	Moon 2 L.	8 22 41,57	
Oct. 2.	ξ^2 Sagittarii	18 47 7,88	2,71
	o ———	54 2,45	
	Moon 1 L.	19 24 26,80	
5.	δ Capricorni	21 37 2,90	3,04
	Moon 1 L.	57 43,05	
	D Aquarii	22 9 16,60	
6.	σ Aquarii	22 20 59,20	2,99
	Moon 1 L.	47 12,70	
	ψ^3 Aquarii	23 9 27,70	
8.	p Piscium	23 49 12,66	2,97
	s Piscium	55 52,54	
	Moon 1 L.	0 25 39,50	
10.	ν Piscium	1 31 43,81	3,15
	Moon 2 L	2 9 32,67	

* In the month of July the moon was several times observed, but it was never possible to observe one of the moon-culminating stars.

J. Moyes, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *December* 14, 1832. No. 16.

THE following communications were read :—

I. Extract of a letter from Professor Santini to Professor Airy, dated Nov. 23, 1832. Communicated by Professor Airy.

M. Santini succeeded in making several observations of Biela's comet, as follow :—

	Mean Time at Padua.			Comet's R.A.			Comet's Declination.		
1832.	h	m	s	°	′	″	°	′	″
Oct. 31.	16	34	43,1	149	35	42,7	+10	43	41,8
	17	10	10,6	149	38	7,9	+10	42	5,3
Nov. 4.	15	57	17,0	155	18	15,4	+ 6	34	44,5
	16	27	2,0	155	19	11,8	+ 6	32	42,5
18.	16	9	44,9	172	46	22,9	− 6	24	52,6
	16	28	27,9	172	47	17,0	− 6	24	50,3
19.	16	30	10,4	173	54	19,0	− 7	13	13,7
	17	17	56,2	173	56	45,9	− 7	14	49,7

On his own observations and those of Sir J. Herschel, M. Santini observes :—

"It is remarkable that its place should have been found nearly intermediate between my ephemeris and that of M. Damoiseau; from which it seems to follow, that the line of perihelion passage was badly determined in both, which is probably owing to the assumption of a constant orbit through the whole period, in the calculation of the co-ordinates for the computation of the perturbations; and as, in May of last year, the comet approached very near to Jupiter, a slight error in these co-ordinates may have had a sensible influence on the perturbation of mean motion, on which depends the return to perihelion.

"I looked carefully for Biela's comet on several evenings in September, with the equatorial of this observatory, but I could not discover any thing that had the least resemblance to a comet. The telescope is one of Fraunhofer's, of three inches aperture, and is very clear. I hear that it was observed at Rome on Sept. 24, with a telescope made by Cauchoix, of eight inches aperture, and that it was extremely faint. I was absent from the observatory from the middle of October to the 31st, on which evening I found it easily between the places given by the two systems of elements, as you inform me Sir J. Herschel saw it in September. At Milan it was observed on Oct. 24. On the last evenings it was very faint and very difficult to observe: in general, the least [illegible] atmosphere extinguished it entirely."

II. Various observations made at the observatory of St. Helena by Lieutenant Johnson; consisting of,

1. Stars observed with the Moon from March to July, 1832.

2. Observation of the solstice of June 1832, containing thirteen direct observations and six by reflection. From the mean of these the following values are obtained, reduced to the 1st of January, 1830:—

N. P. D. of Solstice	66°	32′	16″,45
Obliquity	23	27	43 ,55
The Latitude being	15	55	24 ,00

The circle used in the observation was carefully protected from the Sun's rays.

3. Observation of the Solar Eclipse of July 27, 1832. The first two observations were made by Mr. Armstrong, with a 40-inch achromatic by Berge, power 686; and the last by Mr. Johnson, with a 6-feet achromatic by Gilbert, power 102.

	h	m	s
Beginning* of the Eclipse	2	33	5,4
End	3	32	24,3
End	3	32	25,3

III. Investigation of a rule for clearing the apparent distance of the centres of the Sun and Moon from the effects of parallax and refraction. By Charles Blackburn, B.A., late R.M. College.

In the Monthly Notice for May 1832 is given a formula of Baron Zach for the solution of this problem. The method proposed by Mr. Blackburn is similar in principle, so far as it consists in determining the true distance by the application of certain corrections to the apparent distance; but differs in the manner of obtaining the corrections, which are two in number instead of four. The process is as follows:—

Let δ be the observed distance of the two centres; σ and μ the observed altitudes of the Sun and Moon; $\sigma - d\sigma$ and $\mu + d\mu$ the true altitudes; and S and M the angles made by the observed distance with the verticals passing through the Sun and Moon respectively.

Then $d\delta$ being the correction to be applied to the observed, in order to obtain the true, distance,

$$d\delta = \cos S\, d\sigma - \cos M\, d\mu$$
$$\sin^2 \tfrac{1}{2} S = \operatorname{cosec} \delta \sec \sigma \cos \Sigma \sin (\Sigma - \mu)$$
$$\sin^2 \tfrac{1}{2} M = \operatorname{cosec} \delta \sec \mu \cos \Sigma \sin (\Sigma - \sigma)$$
$$\Sigma = \frac{\delta + \sigma + \mu}{2}$$

Where either of the angles S or M is greater than 90°, the corresponding correction changes its sign.

Mr. Blackburn remarks, "The advantages of this method are, that it is in itself concise; the two parts into which it is divided are perfectly symmetrical, and therefore easily remembered; in looking out the logarithms the seconds may be omitted, and the

* The Eclipse had begun about 10^s before this time was noted.

logarithms taken to four places only; the altitudes themselves are used instead of the zenith distances, which saves the trouble of reduction, and lessens the probability of error."

IV. Observation of the Transit of Mercury of May 5, 1832. Made at Utrecht, by Professor Moll.

The author first notices the observations made in Holland at the preceding transits of Mercury in 1661, 1697, 1753, 1799, and 1802, and then proceeds to state the preparations that were made to observe the present transit. He previously computed the exact times at which the several phases might be expected to take place; but unfortunately the weather was so unfavourable for several days preceding, that no observations could be made for deducing the correct time; and, moreover, the wires of the transit instrument were at that time broken, and consequently could not be used. But, on the 5th, 7th, and 8th of May, several sets of corresponding and single altitudes of the Sun were taken, and the correct times thence deduced.

The telescopes used on the occasion were:—

No. 1. An achromatic by Fraunhofer, of 6 French feet focus, and 52 French lines, or 4,7 English inches clear aperture, power 64.

No. 2. A 42-inch achromatic by Dollond, of $2\frac{7}{8}$-inch aperture, on an equatorial stand, power 76.

No. 3. A Cassegrainian reflector, by Vander Bildt, of $2\frac{1}{2}$-feet focus, $4\frac{1}{2}$-inch aperture, and power of 150.

No. 4. A small Gregorian, power 36.

No. 5. A 42-inch achromatic, by Wilson.

"There was, at intervals, a very strong wind, which compelled me to use small powers. On the whole, I consider the stand of the Fraunhofer one of the worst contrivances which I have ever seen.

"The following table contains the result of the observations:—

Transit of Mercury over the Sun's Disc, observed at Utrecht, 5th of May, 1832.

Obs.	Date. 1832.	Observed Mean Utrecht Time.	Calculated Mean Utrecht Time.	Difference between Observation and Calculation.	Observer's Name.	Telescope.
	May					
Ingress.	4th.	21h20m 7s,801	21h19m31s,44	−0m36s,4	V. Beek, jun.	4
Exterior Contact.		41,268		+1 9,8	G. R. Fockens.	2
		43,268		1 11,8	Dr. Moll.	1
Interior Contact.	4th.	21 23 24,743	21 22 37,44	0 47,3	Dr. Van Beek.	3
		25,273		0 47,8	G. R. Fockens.	2
		25,273		0 47,8	Dr. Moll.	1
Egress.	5th.	4 5 56,957	4 6 59,61	1 2,7	G. R. Fockens.	1
Interior Contact.		6 6,957		0 52,7	Dr. Moll.	2
		8,366		0 51,2	Dr. Van Rees.	5
		8,766		0 50,8	V. Beek, jun.	4
Exterior Contact.	5th.	4 9 10,226	4 11 5,61	1 55,4	Dr. Van Beek.	3
		14,962		1 50,6	Dr. Moll.	2
		17,962		1 47,6	G. R. Fockens.	1

"The Sun's limb was undulating throughout, and near the time of the last contact my telescope was violently shaken by gusts of wind. Immediately after the transit the sky became dark and cloudy.

"The differences between the results of the several observers do not appear greater than on former occasions, and in general they are smaller. In many instances even greater differences have taken place between the results of very able observers.

"The differences between the observations of Mr. Fockens and mine are as follow:—

Ingress	1st contact,	2″
	2d do.	0″
Egress	3d do.	50″
	4th do.	3″

"But at the third contact, my observation agrees very well with those of the others, the differences being,

with Dr. Van Rees, 1″,4
Van Beek, Junior, 1″,8.

"At the last contact of the egress, my observation differs from that of

Dr. Van Beek, 4″,7.

"On former opportunities, astronomers have often not agreed quite so well.

"The planet appeared perfectly round, nor could any of us distinguish any appearance of ellipticity near the egress or ingress, as has been said by other observers.

"I am led to suspect that M. Van Beek, jun., in his eagerness not to miss the first impression, imagined that he saw the ingress a little too soon. However, although his telescope was the weakest, his eyes were the youngest, and this certainly is an advantage.

"Even with such small powers as 64 and 76 of the achromatic telescopes of Fraunhofer and Dollond, I could plainly perceive a grayish spot on the dark disc of Mercury. As soon as I had perceived it, I asked my assistants whether they saw any thing particular on Mercury. One of them instantly replied, '*Do you mean the white spot?*' On applying higher powers (as 110 and 180 to the 42-inch, and 96, 144, 216, and 324 to the 6-feet), the same appearance was always visible. Its periphery was not well defined, but seemed gradually to sink from a grayish white to the dark colour of the planet's disc. It constantly appeared on the same part of the disc.

"After the observation, looking in Schröder's *Hermographic Fragments*, I was much surprised to find that both Schröder and Professor Harding had observed a similar appearance during the transit of 1799. They even attempt a delineation of the object, in which there are two separate spots. I cannot say that I saw any thing resembling this, as it seemed to me and others that there was *one* grayish, undefined spot on the black disc of Mercury.

"I must not here omit the circumstance, that this gray spot was most clearly visible when the eye had had some rest. On applying it then to the glass, it was most easily distinguished.

"The observers at Dr. Van Beek's house saw nothing of this singular phenomenon.

"Some observers state, that in former transits a coloured lighter ring seemed to surround the orb of Mercury on the Sun's disc. According to Plantade, an appearance of the sort was seen at the transit of 1736. Flaugergues saw the same in May 1786, in Nov. 1789 and 1799. He calls it an illuminated ring, *un anneau lumineux*. Nothing, however, of the kind is mentioned in Delambre's account of the transit of 1799, nor in that of Messier of that of 1786. Prosperin and Ferner, however, speak of it as observed during the transit of 1786. But the most circumstantial account of the phenomenon is that of Harding and Schröder, during the transit of 1799. They describe it exactly as we saw it, both with the 42-inch and 6-feet telescopes. *A nebulous ring of a darker tinge, approaching to the violet-colour, appeared to surround Mercury's disc.* Near the planet the colour was darkest. Now, what we saw, and Schröder and Harding saw, is exactly the reverse of what is mentioned by Plantade and Prosperin. They talk of *a luminous ring;* we saw, or at least think we saw, *a darker, more deeply-coloured zone surrounding Mercury.* Ljungberg saw also a dark, nebulous ring round Mercury, at Copenhagen, in 1802.*

"Professor Uylenbroek, of Leyden, allows me to transmit to the Society the observations of Mercury's transit, as made in that university by him and his assistant, Mr. Kaiser. They only obtained an observation of the ingress, the clouds making the egress invisible.

INGRESS.	Mean Leyden Time.	
First, or exterior contact...	$9^h\ 18^m\ 11^s,42$	By Prof. Uylenbroek, with a 42-in.
Second, or interior contact.	9 20 42,42	achromatic by Dollond.
First contact.....	9 17 50,62	Mr. Kaiser, with a 7-feet achro-
Second contact	9 20 50,22	matic by Dollond."

V. Occultation of Saturn by the Moon. Observed at Utrecht by Dr. Moll and Mr. G. R. Fockens, 8th of May, 1832.

Observation.	Dr. Moll.	Mr. Fockens.
Immersion.	Mean Time.	Mean Time.
Satellite	.....	$9^h\ 26^m\ 27^s,48$
Ring, 1st limb.....	$9^h\ 34^m\ 28^s,49$	9 34 22,49
Saturn, 1st limb .	.....	.....
Saturn, 2d limb ...	.....	9 35 32,49
Ring, 2d limb.....	9 36 9,49	9 36 4,49
Emersion.		
Ring, 1st limb.....	10 27 38,58	10 27 30,58
Saturn, 1st limb...	.....	.....
Saturn, 2d limb...	10 28 14,58	10 28 0,58
Ring, 2d limb.....	.....	10 28 6,58

* Zach. Monatl. [illegible] 1803, p. 335.

The same phenomenon was observed at Leyden, by Professor Uylenbroek and Mr. Kaiser, as follows:

Immersion.	h	m	s
Ring's first limb.	9	30	43,2
Saturn's first limb.....	9	31	0,2
Saturn's second limb.....	9	31	59,2
Ring's second limb.....	9	32	31,2

Emersion not observed, on account of clouds.

VI. Remarks on the fifth Catalogue of Double Stars, communicated to the Society, June 7th, 1832. By Sir J. F. W. Herschel.

An account of this communication, the reading of which is not yet finished, will appear in the next Monthly Notice.

VII. Stars observed with the Moon at the Royal Observatory, Greenwich, in the months of October and November, 1832.

There are no observations for September, the transit instrument being then under repair.

		Time by the Transit Clock. h	m	s	Daily losing rate. s
Oct. 2.	ε Sagittarii.....	18	54	5,42	
	Moon 1 L.....	19	24	30,94	0,50
	57 Sagittarii.....		41	54,68	
5.	ϑ Capricorni	21	37	13,34	
	Moon 1 L.....		57	54,24	0,48
	D Aquarii.....	22	9	27,10	
	σ ———		21	12,92	
6.	D Aquarii.....	22	9	26,78	
	σ ———		21	12,80	0,50
	Moon 1 L.....		47	26,88	
	χ^3 Aquarii.....	23	9	40,90	
8.	p Piscium.....	23	50	31,24	
	s ———		56	11,18	0,45
	Moon 1 L.....	0	26	59,00	
	26 Ceti		55	37,54	
16.	β Geminorum.....	7	35	21,94	0,64
	Moon 2 L.....	8	7	41,32	
Nov. 4.	(190) Aquarii	23	40	2,90	
	r Piscium.....		53	29,08	0,68
	Moon 1 L.....	0	4	49,92	
	(120) Piscium		27	3,90	
6.	f Piscium	1	9	16,30	
	s ———		32	49,74	0,66
	Moon 1 L		45	36,56	
	ξ^2 Ceti...	2	19	22,18	
7.	ξ^2 Ceti.....	2	19	21,96	
	Moon 1 L		39	7,38	0,64
	(4) Ceti	3	2	16,86	
	f Tauri		21	44,26	
29.	Moon 1 L	22	7	38,10	
	σ Aquarii.....		22	32,40	0,84
	70 ———		40	26,90	

VIII. Stars observed with the Moon, at the Cambridge Observatory, in November and December 1832.

		Time by the Transit Clock. h m s	Daily losing rate. s
Nov. 1.	Moon 1 L.....	21 36 34,29	3,13
	ι Aquarii	56 15,82	
4.	(190) Aquarii	23 38 39,55	2,72
	τ Piscium	52 5,87	
	Moon 1 L.....	0 3 25,61	
	(120) Piscium	25 40,90	
5.	(120) Piscium	0 25 38,58	2,42
	Moon 1 L	53 0,68	
28.	Moon 1 L.....	21 16 19,35	2,17
	δ Capricorni	36 32,03	
Dec. 15.	δ Virginis	12 46 14,71	2,20
	Moon 2 L.....	13 10 26,54	

December 10, at $12^h\,21^m\,53^s,86$ Cambridge sidereal time, or $19^h\,1^m\,32^s,8$ Greenwich mean solar time, δ Cancri disappeared at the Moon's bright limb. The limb was uneven, and the star seemed to run along one long mountain slope before it disappeared. The time is uncertain two or three seconds.

There was laid on the table, amongst other presents, a MS. copy of Dr. Halley's astronomical observations made at the Royal Observatory at Greenwich, copied from the originals by order of the Lords Commissioners of the Admiralty, and by them presented to the Society.

J. Moyes, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *January* 11, 1833. No. 17.

THE following communications were read :—

I. Remarks on his Fifth Catalogue of Double Stars, communicated to the Society, June 7, 1832. By Sir J. F. W. Herschel.

The present Catalogue is not only more copious than any of the preceding, but contains many more very close double stars.

"Whoever casts his eye down the columns of the Catalogue in question, will not fail to be struck with the occurrence of double stars in which the distance of the individuals (centre from centre) is set down at $1\frac{1}{2}''$, $1''$, $\frac{3}{4}''$, $\frac{2}{3}''$, or even $\frac{1}{2}''$. He will naturally be led to ask, in the first instance, whether I have not in such cases suffered myself to be misled by some optical illusion; and, in the event of all doubt on this point being dissipated, how it happens that with magnifying powers so moderate as those habitually applied to the 20-feet reflector (180, 240, 320, and only in very rare instances 480), it has been able to divide them?

"With respect to the first of these inquiries, it will suffice to shew the *reality* of the observations, and that no illusion has influenced them, if it shall appear that my own and M. Struve's observations—made without previous communication, and each necessarily in ignorance of the other's result—have yet agreed in many very difficult cases, and in some of the most difficult, in assigning as nearly the same relative position to the individuals composing these close objects, as the nature of micrometrical measures in such cases will admit. Granting the possibility of illusion by the reflector giving double images to single stars, *as it occasionally will*, (though such false images may always be *certainly* distinguished from true ones, so that no practised observer, with moderate attention, *can* mistake a star so doubled for a double star), it will not be contended that such illusory images should always assume the same angular situation with respect to the true image, in the observations of two independent observers.

"With a view to this very inquiry, I communicated, some time ago, by letter to M. Struve, my measured angles of position of the following stars: — Σ 305*, 333, 609*, 720, 770*, 1033*, 1093*, 1785*, and 2856*. Of these, the stars marked [illegible] have no angles of position stated in the Dorpat [illegible] far as I know, any where else. Their posi

by possibility have been known to me at the time I observed them. In reply, in a letter dated March 29, 1832, M. Struve communicated his own measures of the same stars, obtained with the great equatorial; and the following comparison of results will shew their general agreement with mine: —

No. of Star.	Angle of Position observed by Herschel.	Angle of Position observed by Struve.	
Σ. 305*	329°,4	332°,7	
333	195 ,0	188 ,9	ε Arietis.
609*	87 ,0	82 ,4	
728	200 ,6	203 ,8	32 Orionis.
770*	333 ,5	339 ,8	
1023*	282 ,6	282 ,2	
1093*	274 ,1	93 ,2	(=273,2−180)
1785*	163 ,8	164 ,3	
2856*	209 ,8	201 ,0	

"Among these, the stars No. 333 and 1093 are remarkable for their closeness; ε Arietis is described as '*in contactu*' in the Dorpat Catalogue; its distance, in the notes to that work, is stated at 0″,51, and its position is there also (from measurement) set down at 186°,9. Of No. 1093 no measure, either of angle or distance, is given; but M. Struve, in his letter above mentioned, states its distance (which I have estimated as 1″) to be only 0″,57 by actual measurement. In the measured position of this star, we agree within a single degree. No. 770, also, is described in the Dorpat Catalogue as '*vicimissimæ, difficilis;*' and the great inequality of its component individuals will account perfectly well for the difference of 6° 3′ in our measures. The star No. 1785 is comparatively coarse, and was included in the list on account of the peculiar circumstances under which it was observed — viz. when *no* star could be seen by the naked eye for clouds. M. Struve's observation, on the other hand, as he informs me, was made *in the day-time*—no slight proof, it must be confessed, of the optical power of the Dorpat refractor.

"Among the list of objects last set down, there are two which have been noticed as offering an appearance of discs, and have been considered as possible cases of planetary nebulæ. This, however, is a bare suggestion of *possibility*. I do not believe them to be objects of that class: their extreme rarity renders it too improbable. Nevertheless, the case is instructive. In my fourth Catalogue I have already noticed the case of Σ 1883 and *h* 639, in which objects at first suspected to have discs, and taken for planetary nebulæ, proved to be close double stars of the order '*pervicinæ*.' It is here impossible not to call to mind the recent experiments of M. Savart, which have shewn that the sequence of two simple indivisible *noises* — two *points of sound*, as they may be regarded — *at an interval* of time less than that of the vibrations of the lowest

note on an organ, is sufficient to excite the sensation of a *musical tone*, or continuous sound, just as in the case before us two points of light sufficiently close in respect of space call up the idea of a luminous surface."

Sir J. Herschel then remarks on the necessity of continued investigation of these objects, as exemplified in the case of ι Ursæ, which was not detected as a double star either by Sir W. Herschel or M. Struve, though within the reach of their instruments:—

"The connexion of double stars with nebulæ is a point of high and curious physical interest, and may not impossibly serve as a connecting link by which something more of the mysterious nature of the latter class of objects may ere long become known to us. Several instances of such connexion occur in my Catalogue, among which the more remarkable is *h* 2827. The individuals of this double star are both considerable stars, of a magnitude between the ninth and tenth, and not less than 15″ apart; and they occupy very nearly the foci of the elliptic outline of a nebula of considerable size, its longer axis being about 50″, and pretty bright. Hardly less interesting, though much less conspicuous (being in fact one of the most difficult objects in the heavens), is *h* 2529, where a minute and very close double star forms the nucleus of a small round nebula. One or two other small stars in the immediate vicinity seem unconnected with it; but the exactly central position of the double star strongly points to a physical relation between them. If we compare the descriptions of these objects with those of *h* 367, *h* 749, *h* 2115, and that discovered by M. Struve, Σ 2332, and figured by him in his Catalogue, it will, I think, be admitted that some other account must be given of the connexion between these double stars and their surrounding nebulæ than that of mere casual superposition. I am much mistaken, also, if the nucleus of Messier's sixty-fourth nebula (which is a very large and bright object) be not a close double star: and what renders this (if verified by further observation) particularly remarkable, is the existence, in the immediate neighbourhood of the nucleus, of a considerable vacuity or space comparatively free from nebulous matter, as if a portion had been absorbed into the star."

With regard to the colour of double stars, Sir J. Herschel has observed no instance in which any star (not in the immediate neighbourhood of a larger red, orange, or yellow one) has excited the slightest suspicions of a preponderance of blue or green in its tint; all stars appearing white which do not tend to yellow or red, provided no lamp or candle-light be near. He considers it probable, that when two stars exhibit colours from opposite ends of the spectrum, the blue or green tint is the effect of contrast.

"I have sometimes been asked for test-objects, to try at once the light and distinctness of a telescope under high powers. In such cases it is desirable to select objects which can be certainly *found*, without the possibility of mistake; and [illegible] I would point out the small double star accompan[illegible]nt.

h 2948, or the small double companion of β Equulei, *h* 3023, as very well adapted for the purpose. A telescope which will shew the *former* of these objects distinctly double, I have no hesitation in saying, must be competent to the most difficult work which any ordinary observer is likely to task it with. No telescope, I ought to add, can be expected to shew the satellites of Uranus (at least in the present low situation of the planet in the ecliptic) which will not stand this test."

II. Observations of the Transit of Mercury of May 4, 1832, made at the Royal Observatory of San Fernando. From Don José Sanchez Cerquero.

These observations were made by MM. Cerquero, Montojo, Hoyos, and Captain Shirreff, R.N., in three different apartments. The sky was cloudless, but the wind and haze caused some difficulty. The telescopes employed were achromatics, by Dollond, of 3½-feet focal length, with triple object-glasses, magnifying power about 80; yet even with this low power the limbs were not steady or well defined.

The means of the results, in time of the standard clock, were,

	Mean Solar Time.		
INGRESS.	h	m	s
External Contact	20	38	33,0
Internal Contact	20	41	41,9
EGRESS.			
Internal Contact	3	23	36,8
External Contact	3	26	53,8

May 5, at noon, clock fast upon mean solar time $3^m\ 3^s,0$; gaining rate, $1^s,615$ a-day.

"At the internal contact, particular care was taken to note the two phenomena seen in the transit of Venus in 1769, or the formation of the black drop (*gutta nigra*) at the contact of the limbs, and the formation of the luminous thread at the separation of the limbs.

"No one of the four observers saw the formation of the luminous thread as an instantaneous phenomenon, or as one which he could note with full certainty, though M. Montojo believed that he saw the drop formed 25^s before the first internal contact. He was not certain of it, and none of the other observers saw it at all. Captain Shirreff believed that he saw the luminous thread at 38^s; but a puff of wind shook his telescope, and he was not certain of the appearance till 40^s."

During the transit, repeated measures were taken of the distance of the planet from the nearest limb of the Sun, by means of a divided object-glass micrometer. As the very high position of the sun rendered the measures by a single observer difficult and fatiguing, the contacts were formed by one observer, and the micrometer read off by another, and *vice versâ*. A careful look-out was kept for the formation of the drop and the instantaneous breaking of the luminous thread; but neither MM. Sanchez nor Shirreff

could see any such appearance, nor was the phenomenon instantaneous.

III. On the Eclipse of the Sun of July 27, 1832, as observed at the Royal Observatory of San Fernando. By Don Sanchez Cerquero.

"The beginning of the eclipse could not be observed with the achromatic telescopes usually employed at the Observatory, on account of the great elevation of the sun. As this circumstance was foreseen, the old equatorial of Dollond was placed on the South Terrace, and the new one in a garret towards the same quarter, with a rotatory conical roof. Don Saturnino Montojo observed the contacts with the former instrument, and Don Sanchez Cerquero with the latter. The time was taken from the regulating clock. The distances between the cusps were measured with the divided object-glass micrometer applied to the new equatorial; and to avoid the loss of time, and inconvenient changes of position, to which the observer would have been liable if the same person had made the contacts and also read the vernier, as the sun had nearly 70° of altitude, one made the contacts while the other read the vernier, and *vice versâ*. The clock-rate was obtained by transits of the stars, the error for the 26th, at midnight, by corresponding altitudes taken by M. Montojo with a Troughton's sextant."

	h	m	s		Eng. Inch.
Beginning of the Eclipse, 2 observers	1	6	10,0	by clock.	Barom.....29,990
Clock fast.....		2	38,57		Exter. Ther. 74°
					Inter. Ther. 87
	1	3	31,43	mean solar time.	
End of the Eclipse, 2 observers.....	3	11	43,25	by clock.	Barom.....29,930
Clock fast.....		2	38,44		Exter. Ther. 76°,5
					Inter. Ther. 85 ,0
	3	9	4,81	mean solar time.	

"The sky was clear during the whole of the eclipse, and the limb of the sun perfectly defined. The wind was fresh from the N.W."

IV. Observations of Biela's Comet, and deduced Elements, by Professor Nicolai, of Mannheim. In a letter from M. Olbers to Sir John Herschel. Communicated by Sir J. Herschel.

The elements deduced by Professor Nicolai are as follow:—

Mean time of perihelion passage at Berlin.....	1832, Nov. 26,09955
Logarithm of perihelion distance	9,8758577
Longitude of the perihelion.....	109° 52′ 55″,1
Longitude of ascending node	248 13 33 ,3
Inclination of the orbit.....	13 10 25 ,2
Logarithm of semi-major axis	0,5486140
Mean daily sidereal motion.....	533″,4400

M. Olbers observes, that these elements coincide very well with those of M. Damoiseau, excepting in the longitude of the perihelion, which difference may perhaps arise from the resistance of a medium.

The comet was not visible in September to M. Harding with a 10-feet reflecting telescope, nor to M. Nicolai with a $4\frac{1}{2}$-feet achromatic by Fraunhofer. Sir J. Herschel first saw it on the 23d of September; it was seen at Rome on the 24th; M. Gambart at Marseilles, and Valz at Nismes, saw it on the 19th of October; M. Bessel on the 20th, and M. Nicolai on the 21st.

M. Olbers forwards the observations of MM. Bessel, Nicolai, and Schwerd.

Encke's comet was seen by M. Mossotti, at Buenos Ayres, on the 2d, 6th, and 7th of June last; and its position agreed remarkably well with the ephemeris, the times of the perihelion differing only by $\frac{1}{100}$ of a day, or half of the same difference in 1828.

V. Stars observed with the Moon at the Royal Observatory, Greenwich, in the months of December 1832 and January 1833.

		Time by the Transit Clock. h m s	Daily losing rate. s
Dec. 15.	δ Virginis	12 47 40,40	0,95
	Moon 2 L.	13 11 53,38	
	Spica Virginis	13 16 53,06	
28.	Moon 1 L.	23 24 32,20	0,71
	(190) Aquarii	23 40 16,18	
Jan. 5.	χ^3 Orionis	5 54 13,06	0,50
	Moon 1 L.	6 45 15,88	
	Moon 2 L.	6 47 45,82	
	q Geminorum	7 12 18,24	
6.	ζ Geminorum	6 54 24,22	0,50
	q ———	7 12 17,54	
	Moon 2 L.	7 55 51,82	
	(42) Cancri	8 10 48,00	
27.	μ Piscium	1 22 21,56	0,62
	Moon 1 L.	1 29 40,62	
30.	(103) Tauri	3 30 53,36	0,62
	Moon 1 L.	4 5 56,20	
	α Tauri	4 27 14,60	
	i ———	4 42 30,82	

VI. Stars observed with the Moon at the Cambridge Observatory, in the month of January 1833.

Jan. 6.	ζ Geminorum	6 53 34,91	1,42
	q ———	7 11 28,01	
	Moon 2 L.	7 55 1,55	
	(42) Cancri	8 9 58,54	
27.	μ Piscium	1 21 21,11	1,30
	Moon 1 L	1 28 39,71	
	α^2 Piscium	1 53 19,39	
	ξ^1 Ceti	2 4 4,18	
28.	ξ^1 Ceti	2 4 2,95	1,40
	Moon 1 L.	2 17 40,86	
30.	(103) Tauri	3 29 50,63	1,42
	Moon 1 L.	4 4 52,52	
	α Tauri	4 25 11,78	
	i ———	4 41 27,89	

J. Moyes, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *February* 8, 1833. No. 18.

Report of the Council of the Society to the Thirteenth Annual General Meeting, held this day.

IN addressing the Fellows of the Society at this their thirteenth Anniversary, the Council cannot but congratulate them on the increased prosperity of their affairs, and on the more extended influence of their Institution. New observatories have been built, and are still building, not only in this country, but in other parts of the world; with all of which this Society has placed itself in active correspondence; — and from these co-operations the most beneficial results may be expected.

Whilst adverting to communications of the kind just alluded to, and at the same time regarding the usual routine of the business of the Society, the Council cannot refrain from expressing their regret (and it has, indeed, for a long time been an annual source of complaint) that great inconvenience is constantly felt from the want of suitable apartments, wherein the business of the Society might be regularly conducted, and their Library and Museum (now not inconsiderable) properly arranged and conveniently consulted. It was hoped, and indeed expected, that before this time the Council would have been able to report some definite result to the applications which have so long been made for apartments in Somerset House; but, up to the present hour, the Council are still in the same state of uncertainty, and regret that they are unable to report more favourably than last year.

In the last Report of the Council, it was mentioned that a Committee had been appointed to consider, arrange, and propose, a set of *Requisite Tables* to be used with the *New* Nautical Almanac. That Committee has since made its Report, which has been communicated to the Lords Commissioners of the Admiralty, who have, with that attention to the interests of navigation which their Lordships have always manifested, directed that a set of Tables shall be computed and formed agreeably thereto. The Report will appear in the forthcoming volume of the *Memoirs of the Society*.

It was also noticed in the last Report, that, in consequence likewise of a communication from the Lords Commissioners of the Admiralty, the Pendulum Experiments of the late Captain Foster had been placed in the hands of a Committee, with a view to obtain results from them. The computations have necessarily taken

much time; but the Council are happy to state, that the whole of them are now completed, and only require to be fairly copied out in a regular series. The Report will then be drawn up with all convenient expedition, and forwarded to Government as early as possible.

The Council regret that the Standard Scale, mentioned in their last Report, has not been finished. It is a work that necessarily takes much time, due attention being requisite to the minutest points which are likely to affect its accuracy. Whilst on this subject, the Council cannot omit noticing a public document laid on the table of this Society at their last Ordinary Meeting, which contains several new and interesting comparisons of two of the principal European standards of length. This document is a Report on a Comparison of Weights and Measures, made by our Associate Mr. Hassler, to the Congress of the United States of America; and has arrived very opportunely, prior to the adjustment of the present standard.

The Council have much pleasure in noticing the favourable state of the finances of the Society, which will best appear from the following detail, deduced from the accounts accompanying the Auditors' Report now lying on the table:—

Receipts.	£.	s.	d.
Balance of last year*	201	8	8
Ditto of Charter Fund.....	129	18	10
1 year's divid. on 800*l.* cons.	24	0	0
Ditto on 1065*l.* 19*s.* new 3½ per cents.	37	6	0
Of Mr. Hawkins, for a silver medal for his private collection.....	0	19	0
On account of arrears.....	77	14	0
74 annual contributions...	155	8	0
1 composition.....	21	0	0
11 admission fees, and first year's contributions.....	44	2	0
3 non-residents who have become residents.....	8	8	0
Sale of Memoirs.....	24	13	6
	£724	18	0

Expenditure.	£.	s.	d.
1 year's rent of apartments	52	10	0
Lights, attendance, &c. at ditto.....	11	5	0
1 year's salary to Assistant Secretary	100	0	0
Engraving two plates, and printing impressions for Memoirs.....	17	2	6
Sundry disbursements for stationery, porterage, postage, &c.....	23	8	4
Collector's commission.....	15	16	6
Balance in Treasurer's hands, Jan. 26, 1833...	504	15	8
	£724	18	0

Assets of the Society.				£.	s.	d.
Balance in the Treasurer's hands				504	15	8
Arrears, Jan. 26, 1833:—						
2 contributions of six years' standing	£25	4	0			
2 ——— of five ditto, and 1 admission fee.....	23	2	0			
3 ——— of four ditto	25	4	0			
2 ——— of three ditto	12	12	0	165	18	0
7 ——— of two ditto	29	8	0			
19 ——— for the year just expired.....	39	18	0			
1 ——— at 4 guineas } for new Fellows.....	10	10	0			
2 ——— at 3 guineas }						
Carried forward.....				£670	13	8

* This balance was erroneously printed 211*l.* 8*s.* 8*d.* in the last year's accounts; and the amount of stationery, &c. only 9*l.* 10*s.* 6*d.* instead of 19*l.* 10*s.* 6*d.*

Brought forward	£670	13	8
1865*l.* 19*s.* stock, valued at about	1700	0	0
Various astronomical instruments, books, prints, &c.			
Unsold Memoirs			
14 unappropriated silver medals			
A sum due by Messrs. Priestley and Weale for Memoirs sold, against which they have an account to set off for printing Memoirs, &c.			

As *one* mode of preventing the accumulation of arrears, and of relieving the Fellows of the Society from too frequent intrusion at times when they may be otherwise occupied, the Council suggest the advantage and convenience which would arise if the several Fellows of the Society, who are annual contributors, would direct their bankers (by means of a printed order, which will be provided for such purpose) to pay the annual contributions as they become due, until countermanded. This will prevent much delay and inconvenience which now attend the annual adjustment of the accounts.

The Balance of the Fund subscribed for the purpose of obtaining the Charter, has been paid by Mr. Baily to the Treasurer of this Society, agreeably to the Resolution of the Subscribers at a General Meeting. The amount was 129*l.* 18*s.* 10*d.*, as stated in the Auditors' Report of the year just expired.

The state of the Society, as regards the number of its Fellows and the different classes into which they may be divided, may be best seen by the following summary annexed to the Auditors' Report, whereby it appears that the total number of Fellows and Associates is 320:—

	Compounded.	Annual Contributors.	Non-resident.	Honorary and Patron.	Total Fellows.	Associates.	Grand Total.
Feb. 1832	53	110	106	2	271	42	313
Since elected	...	14	...	...	14	1	15
Resigned	..	−3	...	...	−3	...	−3
Deceased	−2	−1	...	...	−3	−2	−5
Become resid.	...	...	−2	...	...	...	...
From non-resid.	...	2	...	...	...	...	...
Feb. 1833	51	122	104	2	279	41	320

Amongst the number of losses, by death, which the Society has sustained in the past year, the Council have to mention, with regret, the names of Mr. Groombridge and of two Associates, Professor Oriani and Baron Zach.

The late Stephen Groombridge, Esq., was well known for many years to this Society as one of the most laborious and intelligent of

our members, and a sincere and early friend to our Association, in the formation of which he took a prominent share.

In the year 1806, he became possessed of a splendid transit circle, of four feet diameter, (the workmanship of our celebrated Troughton), so well known by his name and the excellent use to which he applied it; and he immediately commenced the task of forming an exact catalogue of the stars as low as the 8,9 magnitude within 50° of the North Pole.

In this arduous undertaking he persevered with singular assiduity for ten years, and in the year 1816 had completed about 30,000 observations in right ascension, and the same number in declination, on this part of the heavens — a series almost without a parallel in the annals of modern astronomy.

But Mr. Groombridge was not inclined to be satisfied with merely registering his observations: he applied himself with equal industry to the harassing labour of reduction, on which ten years more were exhausted; until, in 1827, he suffered a severe attack of paralysis, from which he never completely recovered. During this period he had applied the reductions which depend upon refraction, as well as instrumental and clock errors, to *all the observations*, and had obtained the mean places of about one-third of the whole number; so that nothing more was required for obtaining the Catalogue, precisely as it would have appeared from his own hands, except to apply the corrections for aberration, nutation, &c., according to his own tables. A request for assistance in computation was made to the late Board of Longitude, and immediately acceded to; and on the dissolution of that Board, the Lords of the Admiralty continued the same aid, with the readiness which has always so honourably distinguished their Lordships. The Catalogue is completed and printed, and will be published very shortly — nothing being now left to be done, except the verification of one or two minor points and deductions.

In the course of these observations, Mr. Groombridge entered into a very elaborate inquiry upon the subject of astronomical refraction, the details and results of which will be seen in two memoirs printed in the *Philosophical Transactions* for the years 1810 and 1814. It would be out of place here to enter into any description of papers which have long been before the public, and which are doubtless well known to the present Meeting; but it is impossible not to notice with admiration the industry of the observer, and the number and delicacy of the observations on which his deductions are founded.

In 1820, Mr. Groombridge presented to this Society his Universal Tables for the Reduction of the Fixed Stars, which are published in the first volume of the *Memoirs* — an extensive, and at the time useful, collection, but which are now perhaps in a great measure superseded by the methods more recently adopted. They differ little in their bases from the formulæ adopted in the Society's Catalogue, and are the tables used in the reduction of his Catalogue of Circumpolar Stars.

In 1822, Mr. Groombridge presented to this Society observations of the Planets during the period of their respective oppositions in 1820, 1821, and 1822, with the computation of their geocentric latitudes and longitudes, which are printed in the second part of the first volume of our *Memoirs;* and, in 1826, a notice on the co-latitude of his observatory at Blackheath, printed in the second part of the second volume. Planetary observations by Mr. Groombridge, chiefly of the new planets, for 1807, 1808, and 1811, from 1812 to 1815, and from 1820 to 1823, are inserted in the Supplements to the *Berlin Ephemeris*, and are of great value for the theory of those planets; as at that time his instrumental means were at least equal to, if not more powerful than, those of any other observer in Europe. In the prosperity of this Society Mr. Groombridge always took a lively interest, and was, as long as his health permitted, an active Member of your Council; and though, in later years, his infirmities did not permit him to be present at our meetings, or to aid us with his advice, no one could be more sincerely respected for his astronomical talents and his individual kindness and sterling worth.

It is seldom that we have to lament a more useful lover of science than Francis Xavier von Zach. He was born at Pesth in Hungary, in 1754, of a noble and distinguished family, and from his very childhood indulged in an ardent pursuit after knowledge, which, aided by an equally strong constitution and mental power, he continued to the day of his death. The striking phenomenon of the transit of Venus in 1769, with the appearance of a comet the same year, directed his youthful assiduity towards astronomy, and those branches of science most connected with it.

Having completed his education, the Baron was anxious to visit the various seats of learning; and, arriving in England, he was received in a flattering manner by the Earl of Egremont and other distinguished persons. It was thus that he became critically acquainted with the language, literature, and state of science in this country. A permanent employment being now desirable, he prevailed on the reigning Duke of Saxe-Gotha to erect a substantial observatory for him, at Seeberg, in 1786, where a series of observations, a Catalogue of 381 Stars, a Catalogue of 1830 Zodiacal Stars, his Solar Tables, and those on Nutation and Aberration, evinced an indefatigable observer and able computer, and placed his name in the first rank of German astronomers. When Ceres was lost sight of, after its first discovery, he was so persuaded of its planetary rather than cometary nature, that he persisted in searching for it, till his endeavours were crowned with success, and he thereby laid the foundation for detecting the other small planets. This was accomplished while he was also completing a map of Thuringia, from an actual survey, for the King of Prussia. Yet these labours had not altogether absorbed his active mind: struck with the advantages of a correspondence which might, in some degree, unite the mathematicians of all countries, he determined, in 1798, to edite an Ephemeris at Weimar, which in a couple of

years ripened into the well-known periodical work entitled *Monatliche Correspondenz.*

In 1814, Baron von Zach published his *Attraction des Montagnes*, in which he attempted to determine the effects of attraction on the plumb-line by a chain of astronomical and geodesial operations, which he had carried on in the preceding year at Marseilles.

Accompanying her serene highness the Duchess of Saxe-Gotha into Italy, where he made numerous celestial observations, he settled for some years in a delightful villa in the eastern suburb of Genoa. Here his first care was to raise a small observatory, and to recommence publishing his *Correspondance;* which, that it might be still more widely available than the former, he printed in French. This work treated of astronomy, geography, hydrography, and statistics; and although conducted with the lively discursive freedom so peculiar to the Baron, it leads to many points of the most abstruse and transcendental inquiry, and moreover has the merit of submitting the whole type of mathematical analysis, instead of abruptly giving mere conclusions—the fault of so many scientific journals.

It is needless to mention the cause of the Baron's unexpected removal from Genoa in 1826, and the general loss which the stoppage of his work occasioned; for about this time a painful complaint rendered application to Dr. Civiale, of Paris, so absolutely necessary, that he took up his abode in that city. There, even while suffering under repeated surgical operations, his animation never flagged; and to the last his natural exuberance of spirits was ever at hand, to relieve the earnestness of discussion. At length, by the skill of the operator, his agonising disease latterly allowed him such intervals of comparative ease, that he even entertained thoughts of revisiting England in the ensuing spring, when he was suddenly attacked by that new and insidious disease the cholera, and died on the 2d of last September, after an illness of only twenty hours.

The Baron was a member of most of the scientific institutions in Europe, a Counsellor of State and Chamberlain of the Court of Saxe-Gotha, and a Knight of the Royal Order of the Black Eagle of Prussia. There are few persons of the age who are likely to be more regretted by the numerous friends to whom his talents, vivacity, sociability, and agreeable manners, had endeared him.

Count Barnaba Oriani, many years Director of the Imperial Observatory of the Brera at Milan, was born at Garegnano, near that city, in 1753. At an early age he removed to the capital, where he soon distinguished himself by a predilection for mathematics and mechanical philosophy. In 1786 we find him conducting the trigonometrical operations for measuring an arc of the meridian over Lombardy. He afterwards continued the Ephemeris so ably begun by La Grange, and inserted in it many able and valuable dissertations on the Lunar Theory, on Refraction, and various abstruse practical and theoretical *desiderata;* whilst his skill in *spheroïdal* trigonometry enabled him to be the first in computing the path and perturbations of Ceres.

Oriani was long known in the scientific circles as the abbate and professor; but he was afterwards much noticed by Napoleon, and presented with the decorations of the Legion of Honour and of the Iron Crown; he was also elected a senator of the kingdom of Italy, and finally acquired the title of count. In private life he was of a pleasing and amiable disposition, and a great encourager of study amongst the youths of his acquaintance. His death, which happened on the 12th of last November, was universally regretted; but it is a consolation to the scientific world, that the lamented philosopher has been succeeded at the Brera by his worthy coadjutor the distinguished Carlini. The following tribute to his memory is from one that knew him intimately—the celebrated Plana, of Turin, who, in the preface to his elaborate *Treatise on the Theory of the Moon*, recently arrived in this country, has the following passage:—"His splendid talents, by which he has rendered illustrious not only the Observatory of Milan, but the whole of Italy, made him highly respected, and caused his loss to be seriously deplored. Honoured with his confidence and his friendship, I could not but admire the purity of his conduct and the nobleness of his character. His modesty enhanced his talents; and the feeling of jealousy for the acquirements of others was to him unknown. No man was more indifferent than M. Oriani to those honours and dignities which had elevated him to the higher classes of society; for the philosopher remained faithful to his principles and his habits; and nothing could suppress his ardour for study, or overcome his inclination for retirement."

The instruments belonging to the Society are disposed as follows:—The Lee Circle is in the hands of our excellent Foreign Secretary, Captain Smyth, of Bedford, and is placed in his observatory, which may be considered as a model of all that a working astronomer's observatory should be. The Beaufoy Circle and Clock are with the Rev. Michael Ward (from whom the Council has received some observations); and the Wollaston Telescope is with Thomas Maclear, Esq., of Biggleswade, to whom this Society has so often and so deeply been indebted for his valuable computations and observations. Mr. Maclear has very recently forwarded a copious list of occultations of stars by the Moon, and of the eclipses of Jupiter's satellites during the last year; and your Council are happy to acknowledge in him one both able and willing, notwithstanding the duties of a laborious profession, to supply the heavy loss sustained by the science in this country, from the death of the lamented Colonel Beaufoy, and the departure of Mr. Henderson to the Cape of Good Hope. Mr. Maclear has now placed his telescope under a rotatory roof; and though scarcely any additional accuracy in his observations can be expected, yet the facilities thus acquired will doubtless relieve him from much of the pressure and tedium of observation.

The Beaufoy Transit is with Mr. Jones, of Charing Cross; and the Clock with Rowland Hill, Esq., for the purpose of making some delicate observations.

A very important addition has been made, in the course of the past year, to the Society's stock of instruments, by John Fuller, Esq., of Rose Hill, a Member of the Society, and a gentleman well known for his great liberality and love of science. This is a repeating theodolite, of twenty inches diameter, made by Mr. Thomas Jones, of Charing Cross, with three microscopic readings, and divided after Mr. Troughton's method — the first trial made by Mr. Jones of this essential improvement in dividing. The upper works resemble, in a great degree, those of the great theodolite by Ramsden, well known from the account given of it in the *Trigonometrical Survey;* and the reversible telescope, which has thirty inches focal length, may be used very conveniently, on a separate stand, as a transit, and is, indeed, fitted up for that purpose. There are several peculiarities in the construction of this instrument, which it is not the place here to describe minutely; but the workmanship and contrivances seem worthy of the high reputation of the artist, and the whole instrument is in as perfect a condition as when it issued from the workshop in 1813.

Your Council have also to return their thanks, in your name, to Captain W. F. W. Owen, R.N., for a double reflecting circle, of his own construction, and a quadruple reflecting sextant after a Dutch model — both executed by Mr. Thomas Jones, of Charing Cross. These instruments are rendered the more valuable by an accompanying description of their purposes and advantages from that accomplished navigator himself; and your Council most heartily join him in his hope, that by these and similar principles, reflecting instruments (which are all-important to our maritime interests) may be carried to a still higher degree of perfection than they now possess.

The other instruments, not in use, are at the disposal of the Council, to be lent to such Fellows of the Society (under the usual printed conditions) as may be desirous of using them; and the Council would have much pleasure in seeing them usefully employed.

In addition to the two presents of instruments just mentioned, the Council have to notice another interesting and valuable present; viz., a manuscript copy of the Astronomical Observations made at the Royal Observatory of Greenwich, by Dr. Edmund Halley, from the year 1719 to 1739, presented by the Right Honourable the Lords Commissioners of the Admiralty. The original observations are contained in four small quarto volumes deposited in the library of the Royal Observatory, and have never yet been printed. They are badly written, and consequently not readily to be referred to or examined; added to which, there is a constant risk of damage, or total loss, by fire or other accident. A representation of these circumstances was made by Mr. Baily, through the medium of Captain Beaufort, to the Lords Commissioners of the Admiralty, and a desire expressed that a fair and legible copy should be made of the whole. Their lordships, justly appreciating the utility of such a measure, and desirous of promoting so laudable an object, imme-

diately gave directions for the execution of the work; and it is now deposited in the library of this Society.

The thanks of the Society are justly due for each and all of these presents; in which sentiment the Council are persuaded that this Meeting will cordially join.

The Council cannot, however, leave this subject without alluding, in terms of great approbation, to the kind offer of your Treasurer, Dr. Lee, and of Lieutenant Raper, to examine and compare the MS. copy above mentioned with the original MS.; a measure which will tend to enhance its value, and render any damage to the original (if ever such should unfortunately happen) of much less moment.

Another offer, of considerable importance, and of great practical utility, has been made to the Council by Mr. Stratford, the Superintendent of the Nautical Almanac; namely, to furnish the Society, for the use of its Fellows and others interested in the subject, with a *working Ephemeris*, for the ensuing year 1834 (and it is to be hoped for the subsequent years), containing all the various phenomena connected with the sun, moon, and planets, to which it is desirable the practical astronomer should attend; arranged in the order of time, as they severally occur throughout the day, and computed for the meridian of Greenwich. A work of this kind has long been a desideratum in the observatory; and the Council have cheerfully undertaken to defray the expense of printing the same, when they are furnished with the manuscript copy.

In the Report made at the last Anniversary, it was stated that an Ephemeris of the position of Mars for his next ensuing opposition had been drawn up, and circulated amongst the different astronomers of Europe, with a view to induce them to make corresponding observations with Mr. Henderson, then about to sail for the Cape of Good Hope, who had undertaken to make special observations on this planet, for the purpose of determining its parallax. This pledge has been redeemed; and the Council are happy in being able to state, that they have recently received from the Lords Commissioners of the Admiralty a series of regular observations connected with this subject, commencing on the 11th of October last; together with a variety of valuable observations on other points, which shew the zeal and talent with which this indefatigable astronomer has entered on the arduous duties of his office. In noticing these documents (which will be laid before the Society in their regular course), the Council cannot avoid adverting once more to the readiness with which their lordships have communicated these interesting papers — at once a proof of their attention to the interests of science, and of their desire to promote objects immediately connected therewith.

Relative to the distribution of materials for promoting the objects of this Society, your Council have to state, that, agreeably to his Majesty's warrant, the Council of this Society (as well as the Astronomer Royal, and the Council of the Royal Society) have now the privilege of being supplied with as many copies of the *Green-*

wich Observations as they may desire, to distribute for the benefit of science. Keeping this object in view, and having before them a list of the persons and institutions to whom the Royal Society have already voted copies, your Council have formed a list of additional names of persons and institutions to whom they consider such copies should be presented; and it is hoped that, between the two lists, no name has been omitted which ought to be inserted. As the list, however, which will be published in the ensuing volume of the *Memoirs*, is always open to correction, your Council will be happy to receive any suggestions for its enlargement.

The Council regret that the Fifth Volume of the Memoirs, which has been for some time in the press, should have been so long delayed. It was expected to have been laid on the table this day: but the Council must request a further indulgence of a few weeks.* The delay has arisen from circumstances over which the Council had no control. As the papers have, of late, considerably increased, it is proposed by your Council that in future the distinction of *Parts* shall be discontinued; and that each published portion of the Memoirs shall be a separate and distinct *Volume*. The Council, anxious to meet the wishes of those Fellows who may be desirous of procuring the several papers as fast as they are printed, hope also to be able to make arrangements whereby any Fellow, on depositing the estimated value of the Volume with the Publisher, may be furnished with *each sheet* of the Volume immediately on its being printed.

Amongst the printed works presented to the Society in the course of the past year, the Council notice, with great satisfaction, the "Description of the Measure of a Degree of Latitude in the Eastern Provinces of Russia," by Professor Struve, one of your Associates. Though inferior in length to the extensive lines measured by the English in India, and by the French in France and Spain, this measurement particularly deserves our attention for the novelty of the methods, both in observation and in calculation, and for the extreme care taken to insure all possible accuracy. It appears that the first idea of this measure was suggested by a survey of Livonia, (for the purpose of mapping), made by M. Struve, in 1816–18. In 1819, the plan of a meridian survey was laid before the Russian authorities, and in 1820 preparations were made by the purchase of instruments, and the preliminary examination of the country. The employments of the Observatory, and impediments of various kinds, prevented M. Struve from seriously commencing the Observations till 1823; and the base was not measured till 1827.

The amplitude of this arc is about 3° 35′, extending from the small town Jacobstadt, on the Düna, to the island Hochland, in the Gulf of Finland. These are connected by twenty-nine principal triangles, and two small ones; three small triangles also being necessary to connect the base with the grand chain. The Ob-

* This volume has since been published, and may now be had at the booksellers'.

servatory of Dorpat is near the middle of the arc. The base was measured with iron rods of two toises each, which had been compared with a toise whose length, as certified by M. Arago, had been adjusted by that of the toise of Peru. The difficulty of producing contact of the rods without disturbance has often been felt; it was obviated here by providing each rod with a *fühl-hebel*, or multiplying lever. Corrections were applied for temperature, flexure, &c.; the base was measured but once, but M. Struve thinks repetition is not necessary. The horizontal angles were measured with Reichenbach's universal instrument, which is a sort of theodolite, the horizontal axis serving also as a diagonal eye-piece: the same instrument was used to determine, by observations of Polaris, the azimuths of sides terminating at Jacobstadt, Dorpat, and Hochland. The latitudes of the extreme stations were found by the use of two 18-inch circles by Reichenbach, in the usual way (rejecting repetitions); all possible corrections being applied for the flexure of the telescope, &c. But the principal reliance was placed on a method proposed by Bessel, but never before extensively used, namely to place a transit instrument with its axis N. and S., and thus to observe the transits of well-known stars over the prime vertical. The triangles were calculated by Legendre's method; but the terrestrial arc of meridian by a method proposed by Bessel, and differing entirely from any that had been used before. Instead of referring the stations to the meridian by parallels and perpendiculars, they are all referred to the Observatory of Dorpat by a sort of polar co-ordinates, the distance from Dorpat being the radius vector, and the azimuth at Dorpat being the polar angle.

Our admiration of the talent and industry displayed by M. Struve in this important measure, will be greatly increased when we recollect that the principal part of the Observations in the Dorpat publication, and the whole of the Observations on which the *Catalogus Novus* is formed, were made during the intervals of the labours of this survey. M. Struve hopes that, though difficult, it may yet be possible to extend the arc both to the north and to the south; in the former case, the celebrated Lapland degree would be joined; in the latter, several mapping surveys in Russia and Prussia would be added to the fundamental arc.

It has long been wished that a set of rules or directions should be drawn up for the use of observers, both in fixed and movable observatories, as well as for travellers who, with more limited means, might occasionally have opportunities of making observations which would be interesting to science; such as for determining the latitude or longitude of a place, the position of a comet, &c.; and adapted not only to those who travel in the civilised parts of the world, but also for those who, in exploring barbarous countries, may frequently be obliged to carry, and even to conceal, such instruments. But, however simple, at first sight, such a plan may appear, it is by no means an easy task to devise a set of instructions which shall be so generally applicable as to include the manipulation and use of the various instruments which may be recommended or employed on

such occasions, and suited to the several degrees of information possessed by individuals who may require them. A committee, however, has been appointed to report on this subject, and the Council would be happy to receive any hints that may tend to perfect the plan proposed.

At the last Annual General Meeting a notice was given by one of the Fellows, that he should propose at the present meeting such an alteration of the Bye-laws, as would authorise the proposal, ballot for, or admission of, candidates, at an annual general meeting of the Society, in the same manner as at an ordinary meeting. The Council have taken the subject into consideration, and now recommend for your adoption the following additional bye-law:—

"*That notwithstanding any thing in the Bye-laws to the contrary, persons desirous of becoming Fellows, may be proposed, balloted for, or admitted, at any Annual General Meeting, as at an Ordinary Meeting.*" *

Should this proposal have the sanction of the present meeting it will be acted upon immediately.

The last subject which has occupied the attention of your Council, has been the annual appropriation of the medal of the Society. In making the selection from the names submitted to them for this honorary reward, the Council feel assured, that in awarding it to Professor Airy, for his paper "On the inequality of long period in the motions of the Earth and Venus," they will receive the concurrence and approbation of this meeting, and be fully justified in the opinion of the scientific world. The medal will be presented this day, in the usual manner, from the chair.

Titles of the Papers read before the Society, between February 1832 *and February* 1833.

March 9, 1832. A Letter from Mr. Snow on the Occultations of 119 and 120 Tauri, and of Regulus.

Observations of the Comets of 1830 and 1831 by different Observers. Collected by Baron Zach, and communicated by Mr. Snow.

Emersion of Aldebaran on Feb. 10, 1832. By the Rev. M. Ward.

A List of Stars observed with the Moon at Blackheath, from August 1831 to January 1832. By Mr. Wrottesley.

Observations made by Lieut. Johnson at the East India Company's Observatory at St. Helena.

A Paper on the Planetary Theory. By Mr. Lubbock.

A Paper on the Rotation of the planet Venus. By the Rev. Mr. Hussey.

* This bye-law was proposed, and unanimously adopted by the meeting.

Observations on the Magnitudes of Stars. By Mr. Birt; communicated by Mr. Lubbock.

A List of Stars observed with the Moon at the Royal Observatory, Greenwich, in January and February 1832. By Mr. Pond.

Occultations and Stars observed with the Moon at the Observatory, Cambridge, in Jan. and Feb. 1832. By Prof. Airy.

April 13. Comparisons of the Right Ascension of Polaris, as obtained by Observation, with that given in Bessel's Catalogue for 1831; and Observations of λ Ursæ Minoris and 51 (Hevelius) Cephei, made with a 5-feet Transit at Blackheath. By Mr. Wrottesley.

This evening Mr. Sheepshanks gave an account of the Mural Circle, with the methods of using it hitherto followed, and a description of the state and defects of the Circle at the Cape Observatory; illustrating his remarks by a model of a Mural Circle lent for the occasion by the Council of the London University.

A List of Stars observed with the Moon at the Royal Observatory, Greenwich, in March 1832. By Mr. Pond.

Transits of the Moon with Moon-culminating Stars observed at Cambridge, in May 1832. By Prof. Airy.

This evening Mr. Baily stated in reference to Dr. Robinson's paper, "On the Dependence of a Clock's rate on the height of the Barometer," read in June last, that he had recently swung the mercurial Pendulum in a vacuum apparatus, and found that a variation of one inch in the pressure of the atmosphere produced a difference of 0,42 seconds a-day in the rate of the Pendulum; which is more than double the quantity deduced by Dr. Robinson from the *observed* alteration of rate when compared with the height of the barometer.

May 11. On the Transit of Mercury which took place on the 5th May, 1832. By the Astronomer Royal; by Mr. Simms, of the Royal Observatory; and by Mr. Riddle. Also Observations of the same at the Observatory, Exchequer Street, Dublin, and measures of the Planet's diameter by Mr. Simms, Fleet Street.

Observations of the Occultation of Saturn on the 8th May, 1832. By Mr. Riddle; by Mr. Simms; by Capt. Smyth; and by the Rev. Mr. Ward.

Observations of the Occultations of 119 and 120 Tauri, on March 9, 1832, at Islington. By Mr. Simms.

Corrections of the formulæ for determining the Longitude from an observed Occultation, with suggestions for simplifying the application of these and other formulæ to the case of corresponding Observations. By Mr. Riddle.

Observations of the Eclipses of Jupiter's Satellites, and Occultations between the years 1827 and 1832, and

measures of Double Stars taken in 1831 and 1832. Also, Observations of the Comet of Ophiuchus, in January 1831. By the Rev. W. R. Dawes; communicated by Sir John Herschel.

A new Method of reducing the Apparent Distance of the Moon from a Star to the true Distance. By Baron Zach.

A Method of finding the rate of variation of the Moon's motion at any instant. By Lieut. Raper, R.N.

On the Determination of the Sun's Parallax, from Observations of the Transit of Venus, June 3, 1769; a posthumous work of Don Joseph Joachim de Ferrer; followed by a Summary by Don Joseph Sanchez Cerquero. Communicated by Sir James South.

An Ephemeris of Encke's Comet for the Southern Hemisphere. By Prof. Encke; communicated by Lieut. Stratford, R.N.

A List of Stars observed with the Moon at the Royal Observatory, Greenwich, in April 1832. By Mr. Pond.

Observations of the Moon and Moon-culminating Stars made at Cambridge Observatory, in April 1832. By Prof. Airy.

June 8. Observation of the Transit of Mercury on the 5th May, 1832, at Lisbon. By the Rev. J. Fisher; communicated by Capt. Beaufort.

Observations of the Occultation of Saturn on 8th May, 1832. By Mr. Lawson, by Mr. Holehouse, and by Mr. Snow.

Observations of the Solstices from December 1829 to December 1831; and Observations of Moon-culminating Stars during the year 1831, made at the Hon. East India Company's Observatory, St. Helena. By Lieut. Johnson; communicated by Capt. Beaufort.

On the Calculation of the Geographical Longitude and Latitude of a place, whose geodesic distance from the Meridian and perpendicular of another place is given, the Earth being considered as a spheroid. By Baron Zach.

Mean Right Ascensions of Fifty-five unknown Stars, observed in 1831, with a Transit Instrument of 20-inches focus, and a sidereal Chronometer beating half seconds; also Occultations observed in March 1832. By Mr. Snow.

Fifth Catalogue of Double Stars observed at Slough in the years 1830 and 1831, with the 20-feet Reflector, and reduced to the Epoch 1830,0. By Sir J. F. W. Herschel.

Observed Occultation of Aldebaran. By Mr. Rothwell; communicated by Mr. Tulley.

Stars observed with the Moon at the Royal Observatory, Greenwich, in May 1832.

This evening Mr. Sheepshanks made some remarks upon the mode of adjusting the Transit Instrument, and described minutely the various corrections requisite for obtaining correct results, illustrating his statement from various Transit Instruments furnished for the occasion by Messrs. Troughton and Simms.

Nov. 9. Observations of Biela's Comet, by Sir J. F. W. Herschel; with interesting remarks on the appearance of the Comet.

On the method of ascertaining the rates of Chronometers; especially when a strict examination of their performance is required. By Mr. Epps, Assistant-Secretary of the Society.

Observations of the Transit of Mercury on May 5, 1832. By Prof. Quetelet, at Brussels; by Mr. Henderson, at the Cape of Good Hope; by Capt. Bayfield, lat. 46° 48′ 50″ N., long. 71° 16′ W.; by Capt. R. Owen, R.N., lat. 22° 47′ 20″ N., long. 74° 18′ W.; by Capt. Belcher, R.N., at Cavalho Island, Bijoogas; and by M. Cacciatore, at Palermo.

Observations of the Occultation of 104 Tauri, October 13, 1832, and of μ Ceti, Nov. 7, 1832. By Mr. Snow. Accompanied by the Transits of the Stars used to correct the Clock.

Observations of the Occultation of Saturn, May 8, 1832. By Prof. Airy and Mr. Maclear at Cambridge, and by M. Cacciatore at Palermo.

Stars observed with the Moon at the Royal Observatory, Greenwich, in June, July, and August, 1832. By Mr. Pond.

Observations of the Transits of the Moon with Moon-culminating Stars, made at Cambridge Observatory in August, Sept., and October, 1832. By Prof. Airy.

Dec. 14. Extract of a Letter from Prof. Santini to Prof. Airy, containing Observations of Biela's Comet.

Various Observations made at the Observatory of St. Helena, by Lieut. Johnson; consisting of

1. Observation of Stars with the Moon from March to July 1832.
2. Observation of the Solstice of June 1832.
3. Observation of the Solar Eclipse of 27 July, 1832.

Investigation of a rule for clearing the apparent distance of the Sun and Moon from the effects of parallax and refraction. By Charles Blackburn, Esq.

Observation of the Transit of Mercury on May 5th, 1832, and of the Occultation of Saturn on May 8th, 1832, made at Utrecht. By Prof. Moll.

Remarks on the 5th Catalogue of Double Stars, communicated to the Society June 7, 1832. By Sir J. F. W. Herschel.

Stars observed with the Moon at the Royal Observatory of Greenwich, in October and November 1832. By Mr. Pond.

January 11, 1833. Observations of the Solar Eclipse of 27th July, 1832, made at St. Fernando. By M. Cerquero.

Observations of the Transit of Mercury, May 5th, 1832, at St. Fernando. By M. Cerquero.

Observation of Stars with the Moon at the Cambridge Observatory, in November and December 1832. By Prof. Airy.

Observations of Biela's Comet, and deduced Elements, by Prof. Nicolai, of Mannheim. In a Letter from M. Olbers to Sir J. Herschel. Communicated by Sir J. Herschel.

List of Public Institutions, and of Persons, who have contributed to the Society's Library, &c. since the last Anniversary.

The Lords Commissioners of the Admiralty.
Royal Society.
Royal Asiatic Society.
Royal Society of Edinburgh.
L'Académie Royale des Sciences de l'Institut de France.
Le Bureau des Longitudes.
Cambridge Philosophical Society.
Academy of Sciences at Dijon.
Italian Society at Modena.
American Philosophical Society at Philadelphia.
Society of Arts.
Society of Physics and Nat. History at Geneva.
Geological Society.
Zoological Society.
Editor of the Athenæum.
Editor of the United Service Journal.
British Association.

Professor Airy.
Professor Argelander.
Professor Bessel.
Professor Bowditch.
Professor Cacciatore.
M. Cerquero.
M. Corabœuf.
Professor Encke.
John Fuller, Esq.
Professor Gauss.
Stephen Groombridge, Esq.
Professor Hansen.
Professor Hassler.
M. Marcoz.
Captain W. F. W. Owen, R.N.
Messrs. Parkinson & Frodsham.
M. Plana.
Professor Quetelet.
Dr. Robinson.
Charles Rumker, Esq.
Professor Schumacher.
Charles Shearman, Esq.
William Simms, Esq.
Professor Struve.
Richard Taylor, Esq.
Rev. Mr. Whewell.

(The Vice-President then addressed the Meeting on the subject of the award of the Medals, as follows:—)

It now becomes my pleasing duty to deliver, from this Chair, the Medal which has been awarded by your Council. But, previously to my so doing, I beg leave to say a few words on the subject to which that medal relates: a subject, which is perhaps amongst the most abstruse and refined of any to which the human mind can aspire.

When Newton published that important work on the mechanism of the heavens, which has rendered his name immortal, he probably was not aware of the full extent and influence of those sublime truths, and those new views which he had laid open with so much penetration and skill. Vast as were the resources of his clear and powerful mind, there were still some parts of the system left untouched by him; some subjects with which he would not, at that period, undertake to grapple. With a firm and masterly hand he had sketched a bold and beautiful outline, and even filled up, in the same skilful manner, all the prominent and many of the more minute points of the picture: still, however, leaving some of the finer touches to be supplied by those who might succeed him.

Amongst the less perfect parts of the system developed by Newton, may be reckoned that which relates to the cause of certain small irregularities or disturbances in the motion of the *Planets*. Yet such was the respect paid to the authority of his great name, so vastly superior was he to any of his contemporaries, that nearly 60 years elapsed before there was an attempt to make any material additions to that splendid edifice, the foundations of which he had laid with such consummate skill. The first that ventured to approach this sacred temple, not for the purposes of attack, but to improve, was Clairaut; who may be considered, after Newton, as the first that investigated the method by which the cause of the planetary disturbances is explained, and their effect computed.

If, in our view of any portion of the solar system, we confine our attention to the case of *two* bodies only, revolving round each other (such as the sun and a planet, or a satellite and its primary) the two great truths first developed by Kepler, viz. the equable description of areas and the elliptical form of the orbit, would be strictly preserved: and by the help of certain elements determined by observation, the place of the revolving body could, under such circumstances, be readily ascertained, for any given moment of time, without much difficulty.

But, if a *third* body be brought within the sphere of their influence (and let the number be ever so great, the investigation is necessarily confined to this simple consideration), the case is very materially altered, and becomes extremely complicated; and that which before admitted of a comparatively easy solution, now becomes one of the most difficult problems that ever exercised the talent and ingenuity of the most profound mathematician: a problem which, for the sake of distinction has been denominated

the *Problem of three bodies;* a term applied, by common consent, to that investigation wherein it is required to find the laws of motion, the magnitude, form and inclination of the orbit of a body revolving round another as a centre, but disturbed in its motion and position by the influence of a third body at a distance. As every moving body in the system is thus circumstanced (since each is subject to the action of every other body in the universe), it is evident that this problem is of very extensive application and of great difficulty: and its solution has consequently been the object of the most acute and profound geometers from the time of Newton to the present day.

The problem, indeed, does not admit of a rigorous and accurate solution; and can only be solved by approximation, founded on investigations of the most abstruse and difficult nature. But, the amount of the perturbations is fortunately very small, which tends to facilitate the inquiry; as we are thus enabled to preserve the simple case of *two* bodies, as a preparatory step to the consideration of the subject: since its results, with some slight modifications, belong to it. For, in the words of an eminent professor,* "an exact ellipse is described only when there are *two* bodies; and a curve, differing but little from an ellipse, when there are *three* or more bodies. The coincidence of the curve, described in the first instance, with a simple curve of known properties, has been the cause why the elliptical motion of a planet is considered as its natural and proper motion: and, accordingly, (in order that there might be no incongruity of language) why a third is called a *disturbing* body; for its action obstructs the operation of the laws of elliptical motion. This however (as is evident) is mere mathematical fiction and contrivance. An ellipse is not the curve that is really described: but that curve is described, the equation of which is assigned by the solution of the problem of three bodies."

Now, when we consider the variety of circumstances in which any two, or more, planets, influencing each other, may be placed, with respect to the direction of their motions, the inclinations of their orbits, and their mutual distances; that almost every part of the elliptical system is thereby disturbed, such as the positions of the planets in their orbits, their inclinations, aphelia, and nodes; and when we further reflect, that all the planets in the system are exercising their influence on each other, and thus more or less disturbing the motions and positions of the whole; when these and other points of equal intricacy (but which cannot conveniently be enlarged upon in this place) are taken into consideration, any person, not even professing to be conversant with the more refined branches of analysis, may readily *imagine* the difficulties to be encountered in obtaining only an approximate solution of the important problem above alluded to. Whilst those who are better versed in the subject, and claim a more perfect acquaintance with the higher branches of mathematics, *know* too well the arduous task of even following,

* Woodhouse.

much more of verifying, the various steps of the investigations made by the great masters that have preceded them.

I have already remarked that Clairaut was, under Newton, the first who attempted to investigate the laws, by which the planetary disturbances are governed. Newton himself, although he pointed out the road, did not specially enter on the subject; probably considering the quantities too minute. From that period to the present day, the list is but small, of those who have ventured to attack this profound and intricate inquiry. Clairaut, D'Alembert, and Euler, may be considered as the founders of the *planetary theory*: a term given to that investigation which, whilst it determines the elliptical place of any given planet, points out not only the perturbations caused by the action of the other planets, but also the variations produced by such perturbations, in its position, and in the dimensions of its orbit.

In these investigations, it is impossible for the mathematician to take into account all the quantities that arise in the several steps of the process, or to retain them for computation: some must necessarily be rejected, or rendered more simple by various contrivances, not solely at the mere will of the analyst, and for his own convenience, but from the absolute insufficiency of the means of computing them. And it is no easy consideration to determine what terms ought to be rejected and what should be retained; since no rules can be previously laid down for the limitation: and the decision must depend on the form which they assume *after* integration. In the pursuit of this inquiry, the distinguished mathematicians, above mentioned, have had recourse to various methods of approximation, founded on the most abstruse and intricate parts of the differential and integral calculus.

Even after all the labours of these great men, and after they had reduced the perturbations of the planets to something like a regular system, agreeing tolerably well with observation, there still remained an unexplained anomaly in the motions of *Jupiter* and *Saturn*, which had long perplexed the astronomer, not only from its magnitude, but more especially from its not being reducible to any of the known principles deduced from the theory of gravitation. It was long known that the mean motion of *Saturn* was retarded, whilst the mean motion of *Jupiter* was accelerated: and the amount of this mutual variation was too great even to escape the observation of the more ancient astronomers. How much therefore must it have perplexed the mathematician to find that such an obvious anomaly was not only inexplicable on the theory so recently developed by Newton, but evidently impugned that theory: an advantage that was readily seized by his opponents.

Euler had attempted the investigation of this subject; but he experienced so many difficulties in the pursuit, and his results accorded so little with observation, that he ultimately abandoned the design. La Grange also took up the inquiry; but at first, with imperfect success. In the mean time La Place, to whom every branch of physical astronomy is so highly indebted, directed the resources of his powerful and sagacious mind to the elucidation of

this intricate subject: and in his first essay succeeded so far as to shew that the disturbances of these two planets were not of a *secular* nature, but that they must necessarily be *periodical:* a result in which he was confirmed by the investigations of La Grange. This deduction was a great step towards the solution of the problem, since it in some measure contracted the inquiry, and indicated that the inequality was one of *long period*, and to be sought for in the general analytical expression for the problem of three bodies. At length La Place detected the true cause of the apparent anomaly above alluded to, as I shall now proceed to shew.

In forming the differential equation expressing the conditions of the disturbed body, the terms that involved the third and higher powers of the excentricities, had generally been rejected on account of their presumed minuteness. But amongst these rejected quantities, it occurred at length to La Place, that there might be some which, if integrated, would have very small divisors, and consequently become of an appreciable value. To follow out all these terms would be a truly Herculean task, which might not be repaid by the labour of the inquiry. The genius of that illustrious geometer, however, penetrating through this labyrinth of interminable calculations, enabled him to limit the inquiry: and after much laborious research, he found a clue to the principal object he had in view. For he ascertained that, in consequence of the near commensurability of the mean motions of *Jupiter* and *Saturn* (which are nearly as 5 to 2), those terms only, in the resulting expression, need be retained, which, after integration, admitted in their denominator a quantity depending on five times the mean motion of *Saturn*, minus twice the mean motion of *Jupiter;* and that, in the expansion of the series, the investigation need not be extended beyond those terms where the co-efficients are of the third order, or such as are indicated by (5—2): principles which we shall find extended to the investigations which form the subject of the present address.

Still the labour of reduction was immense, and sufficient to appal the most intrepid computist: but he was fortunately assisted by Burckhardt in his researches, who extended the terms to the 5th order. The result of the whole indicated a considerable inequality, of very long period; for his analytical expressions being reduced into numbers, he found that the great inequality of *Saturn* was 48′ 44″ and its period 919 years: that the corresponding inequality of *Jupiter* was comprised within the same period, but affected with a contrary sign, and diminished in the ratio of about 7 to 3: that the two inequalities were at their maximum (+ for *Jupiter* and — for *Saturn*) about the year 1560: and that ever since that time the mean annual apparent motions of the two planets have been approaching the true mean motion, till the year 1790, about which time they were both equal: since which epoch they have been again diverging, but in a contrary order; all which are found to be agreeable to observation.*

* The values here stated are those first given by La Place; which have since been subjected to corrections by subsequent observations.

Thus it was shewn that these apparent anomalies in the motions of *Jupiter* and *Saturn*, which seemed at one time to impair the Newtonian system, have only tended more effectually to strengthen and confirm it. We here see, as in many other instances in physical astronomy, the practically good effects of theory: since it points out to us many objects of research which, from their minuteness would either be frequently overlooked by the mere practical observer, or become sensible and apparent only after a lapse of many years. In this respect it may be considered as no longer going hand in hand with observation, but as advancing before it, and serving it as a guide.

Such was the state of the planetary theory when Professor Airy in 1828 communicated to the Royal Society his paper "On the corrections in the elements of Delambre's solar tables." In that elaborate paper he detected certain anomalies in the motion of the sun, indicated by a laborious comparison of upwards of 1200 observations made at the Royal Observatory at Greenwich, and not explicable by the usual formulæ for planetary perturbations. And although he was at that time unprepared to demonstrate the origin and cause of those irregularities, yet, in the postscript to that paper, he expressed his firm conviction that they arose from an inequality of long period, depending (as in the case of *Jupiter* and *Saturn*) on the near commensurability of the mean motions of the *Earth* and *Venus*: or, on 13 times the mean motion of the *Earth*, minus 8 times that of *Venus*, and that its period was 240 years. The amount of the perturbation at its maximum, was indeed very small, not much exceeding two seconds of space: but this was at once a proof of the scrupulous accuracy of the inquiry, and of the refinement of modern observation.

To detect the true cause of this minute anomaly, Professor Airy, shortly after, resumed the inquiry; and in a subsequent paper read before the Royal Society, entitled "On an irregularity of long period in the motions of the *Earth* and *Venus*," he has given a detail of the methods by which he obtained the result in question: and it is for this paper that your Council have now awarded the Gold Medal of the Society.

In the course of his investigations he perceived that, although in the ordinary case of the planetary perturbations it had been usual to restrict the inquiry to those terms where the co-efficients were of the second order, and that although in the case of *Jupiter* and *Saturn* it might be limited to terms of the third order, yet in the present case it was requisite to extend them as far as the fifth order; or to such as were indicated by the near commensurability of the mean motions of the *Earth* and *Venus*; that is by 13—8. And although such quantities, in the differential equations, would be very small, yet in the integration and subsequent process they would receive a multiplier of 2,200,000; and thus become of an assignable magnitude. The labour of the investigation was therefore prodigiously increased; and we cannot but admire the patience and perseverance of Professor Airy, in having himself gone through the

Herculean task of computing the numerical values, and by two different modes, in order to insure the accuracy of the result. When, therefore, we consider the immense labour and difficulty of conducting an inquiry of this kind; when we bear in mind that such men as Euler and La Grange have been foiled in their attempts to elucidate a more prominent and striking case than the one in question; and that even the investigations of La Place (assisted, as they were, by Burckhardt) have been since found in some instances erroneous, and that they have required and received the correcting hand of some of the most eminent mathematicians of the present day; we may, without the labour of a minute inquiry, form some idea of the merit due to Professor Airy for having pursued this subject to so successful a termination.

The numerical result of the whole shews that the maximum amount of the inequality in the longitude of the *Earth* is 2″,06; and in that of *Venus*, 2″,95: * that the period is 240 years: that the two inequalities were at their maximum (+ for the *Earth*, and — for *Venus*) in the year 1682; and also, but with a contrary sign, in 1802. In order to point out the importance of these corrections in the tables of *Venus* and of the *Sun*, Professor Airy has estimated roughly the places of the *Earth* and *Venus*, at the next transit of *Venus* over the sun's disc in 1874: and he states that "if the mean motions of the *Earth* and *Venus* were determined by comparing the observations, about Bradley's time, with the observations made a few years ago, the *Earth's* longitude in 1874 (when the inequalities are nearly vanishing) would be too small by nearly 4″; and that of *Venus*, too great by 6″: their difference of longitude would therefore be nearly 10″ in error: and this would produce, on the geocentric longitude of *Venus*, an effect of between 20″ and 30″." It is evident, therefore, that this inequality, although so minute, could not long have remained undetected in the present advanced state of practical astronomy; but would be sufficiently obvious and perplexing at that period. We are, therefore, the more indebted to Professor Airy, not only for having foreseen this anomaly, but also and more especially for the vast labour bestowed in its elucidation, and for the talent and skill displayed in conducting the investigations which have led to so satisfactory a result.

There is, however, another important remark which it is requisite to make in this place, (and I mention it with pride and satisfaction), that this is the first successful attempt made by any Englishman, since the time of Newton, to improve the planetary tables. Much, as we have already seen, has been done on the continent to bring the planetary system to perfection: but, few are the names which, in the country that claims Newton for its own, can boast of having added to this stock of information. Let us hail the present, then, as the harbinger of happier times, and trust that the zeal and perseverance shewn by the distinguished author of this memoir, may

* Since the above was written, I have been informed that M. Pontécoulant has verified the result given by Professor Airy.

stimulate others of his countrymen to extend their researches into the more refined and intricate branches of physical astronomy.

(*The Vice-President then, addressing Professor Airy, continued thus:*—)

Professor Airy, in the name of the Royal Astronomical Society, I present to you this medal, which has been awarded by the unanimous vote of their Council. You will accept it, Sir, as a small tribute of their respect and admiration for those rare talents which you have displayed, and for that great labour which you have undergone, in detecting the minute inequality in the motions of the *Earth* and *Venus*, in developing the cause of that anomaly, and in expounding the law by which the same may be made available to the practical observer.

But, were I thus to limit my address to this mere formal expression of their opinion, I should not do justice to my own feelings on this occasion, nor satisfy the expectation of those who now hear me. Your name, Sir, is inseparably connected with the scientific history of Europe, and is enrolled amongst those bright and illustrious characters that have enlightened it by their various labours. The several branches of pure and mixed mathematics, to which you have more especially devoted your attention, and the various researches that have arisen from those inquiries, have all felt the influence of your vigorous and powerful mind: and as director of that splendid observatory, the affairs of which you conduct with so much honour to yourself and so much benefit to astronomy, you have, by giving to the world the *reduced* as well as the recorded observations, set a noble example to other establishments of a similar kind, which, it is to be hoped, will soon be followed by them all. By these and other exertions in the cause of science, you have not only exalted your own name, but at the same time raised the reputation of the University, of which you are so distinguished a member, and added to the scientific character of your country. And I trust you will long enjoy the fruits and blessings of such well-earned fame.

The Meeting then proceeded to the election of the Council for the ensuing year, when the following Fellows were elected, viz.

President: Francis Baily, Esq. V.P.R.S. F.L.S. & G.S. & M.R.I.A.—*Vice-Presidents:* George Biddell Airy, Esq. M.A. *Plumian Prof. Ast. University of Cambridge;* Captain F. Beaufort, R.N. F.R.S.; Davies Gilbert, Esq. F.R.S. L.S. & G.S.; John William Lubbock, Esq. M.A. V.P. & *Treas.* R.S.—*Treasurer:* John Lee, Esq. LL.D.—*Secretaries:* George Bishop, Esq. Augustus De Morgan, Esq.—*Foreign Secretary:* Captain W. H. Smyth, R.N. F.R.S. & A.S.—*Council:* Bryan Donkin, Esq.;

Lieutenant Thomas Drummond, R.E.; Thomas Jones, Esq.; Rear Admiral Sir Edward Owen, K.C.B.; Lieutenant Henry Raper R.N.; Edward Riddle, Esq.; Rev. Richard Sheepshanks, M.A. F.R.S.; Robert Snow, Esq. B.A.; Lieutenant William S. Stratford R.N. F.R.S.; Thomas Turner, Esq. M.A.

J. Moyes, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *March* 8, 1833. No. 19.

THE following communications were read:—

I. On Prof. Bessel's improved method of deducing the Longitude from a Lunar Distance. By Lieut. Stratford, R.N.

"In the *Astronomische Nachrichten*, Nos. 218, 219, and 220, Professor Bessel has given a new method of reducing a lunar distance, which, in my opinion, will render this celebrated problem as available to the landsman, for the determination of his longitude, as it has hitherto been to the seaman, and to a degree of accuracy limited only by the extent of our knowledge of the moon's true theory. With the view of making it more generally known in England, I here present the Society with an outline of Bessel's plan, accompanied by such remarks on the subject of lunar distances generally, as appeared to me requisite for the proper appreciation of its merits.

"In the *Nautical Almanac*, as well as in some of the ephemerides published in Europe, the distance of the moon's centre from certain objects is given at intervals of three hours, as it would appear to an observer placed at the centre of the earth: in other words, it is the true angular distance of the centre of the moon from the star, corrected for aberration only. This distance being independent of geographical position, would be observed at the same *absolute* moment of time at all places; if, therefore, we know the *relative* times under different meridians at which the phenomenon occurs, we obtain immediately, as in the case of an eclipse of the moon or of *Jupiter's* satellites, the difference of those meridians.

"An observation, however, of a distance at the surface of the earth, is made under very different circumstances, and is not, therefore, comparable with the tabulated distance until it has been reduced to the same state. In the tabulated distance, allowance has been made for aberration only, this operating equally at the centre and the surface of the earth. In the observed distance, the limbs of the objects have been taken instead of the centres—the positions of the objects are apparent not real, on account of refraction; and were there no atmosphere, they would still be different on account of parallax, produced by the change of position of the supposed observers.

" When the observation of the limbs at the surface of the earth has been corrected for semi-diameter and refraction, we have the true distance of the centres at the surface; and this being further corrected for parallax, we have it as it would appear at the centre, and in a fit state for comparison with the tabulated distance.

" All the various approximate methods of reducing a lunar distance are founded on the same principle, viz.

" There are given two triangles whose sides are respectively the *apparent* zenith distances and the *apparent* distance, and the *true* zenith distances and the *true* distance, the angle at the zenith being common to both triangles.

" The sides of the first triangle are given by the observations, and the angle at the zenith thence deduced. The observations being corrected for refraction and parallax, furnish two sides of the second triangle, with which, and the included angle, viz. the angle at the zenith already found, the third side, or the true distance, is obtained.

" The accurate solution of the problem requires,—

" 1. That we know the exact state of the atmosphere as regards temperature and density, in order to the obtaining the correct amount of refraction.

" 2. That we know the apparent altitude of the centres of the objects. The vertical semi-diameters should, therefore, be corrected for refraction before they are applied to the observations of the limbs.

" 3. The angles at the star and moon with the zenith, in order to an accurate estimate of the effect of refraction on the oblique semi-diameters lying in the circle passing through the centres of those objects.

" 4. That we know our latitude, an element particularly necessary in the proper reduction of every thing relating to the moon.

" Now, these are refinements that the sailor never dreams of, and perhaps they may be considered as of little or no importance, when he can scarcely be expected, under ordinary circumstances, to have his primary element, the *time*, correct to within any thing like the amount of error produced on the longitude by the omission of the whole of the minute corrections. He is satisfied with the diameters as given in the *Nautical Almanac*, with *mean* refractions and *equatorial* parallaxes; and with these he reduces, by some of the simplest approximate methods, his observation made at the surface to what it would be if made at the centre, without regarding the spheroidal figure of the earth. Not so, however, the landsman; he has his transit and clock, therefore his time to the greatest possible degree of accuracy; he is fixed, his latitude ascertained, his meteorological instruments about him; in short, he has every facility for obtaining accurate data for the rigid solution of the problem.

" Bessel's method is new in application, though not in principle; it is what we are accustomed to in every day's practice; it consists in the reduction of the tabulated quantities for the centre to compare with instrumental results at the surface, instead of the reduction of the observations themselves for comparison with the central quantities, the method commonly pursued.

" To illustrate the method,— Suppose a person at Paris, the difference of longitude of which from Greenwich is tolerably well known, to observe the distance of the moon from a star; it is very clear, that with the knowledge of the time of observation, we could compute, with the aid of the *Nautical Almanac* constructed for the meridian of Greenwich, the distance at that time, and that it ought to agree precisely with the observation, the only possible cause of disagreement, if any, being the inaccuracy of the lunar tables.

" Suppose the tables to be accurate, but that we do not know exactly the difference of longitude, what would be the consequence? A certain disagreement between the computed and observed distance, and attributable entirely to an erroneously assumed difference of longitude; for, as all our data for the computation of the distance were taken from the *Nautical Almanac*, for a time, of which the assumed difference of meridians is a component part, the data must be wrong, because the Greenwich time is not accurately known.

" If we knew, however, the variation of the distance of the bodies for one second of time, this, and the difference of the results, affords us a ready means of correcting our assumed longitude, and thus of approximating to any desired degree of accuracy, just as in the analogous case of an observed occultation.

" Some of the principal advantages of Bessel's method are, 1st, he obtains his data from the best possible sources, and thus arrives at the accurate value of the corrections; 2d, that by the mode of applying the corrections he never vitiates the instrumental result; 3d, the altitudes are unnecessary, an observation of the distance and the time being all that is required; 4th, the observation may be repeated at any time, and multiplied without limit.

" The chief labour of executing Bessel's method would fall upon the computers of ephemerides. In addition to the distances for every third hour, there would be required the angle at the moon formed by great circles passing through the sun and the pole; the log. sin. of horizontal parallax, and the log. of the semi-diameter of the moon, the star's meridian distance and its declination, together with logarithms of certain quantities, required in conjunction with the latitude, for the reduction of the tabulated geocentric quantities to their proper values for the spheroid, previously to the application of parallax.

" With an ephemeris containing these values, the difference of longitude is obtained as follows: —

" M. Bessel supposes the difference of longitude m between the place of observation and the meridian for which the ephemeris is made, to be approximately known, and proceeds to find the correction x from a comparison of the observed distance D', of the moon's limb from a star, and the computed distance obtained from the time of observation T, and the data taken from the ephemeris; that is, for the Greenwich time (supposing the *Nautical Almanac* to be used) he takes from the ephemeris the geocentric distance of the moon from the star and the other quantities. With the corrections, and the given latitude, he reduces the elements, as given for the centre, to

what they would be at the point of intersection of the vertical with the polar axis, or, as it is generally termed, corrects those elements for the spheroidal figure of the earth. He then further corrects that distance for parallax; and lastly, for refraction, the final result D compared with observation, gives

$$\text{the correction } x = \frac{D' - D}{n'}$$

where n' is the variation of D for one second.

" He first solves the problem rigorously, and afterwards shews the seaman what may be thrown overboard, without much affecting the result as regards his peculiar circumstances, and gives formulæ for the carrying out of his method, which, with a very superior degree of accuracy, costs about a similar amount of labour with many of the methods in general use.

" I am much gratified in being able to inform the Society, that an ephemeris on Bessel's plan, for the year 1834, is now in progress, under the direction of Professor Schumacher."

II. Transits of the Moon with Moon-culminating Stars, observed at Cambridge Observatory, in the month of February 1833.

		Time by the Transit Clock. h m s	Daily losing rate. s
Feb. 2.	*d* Geminorum	6 41 20,44	
	Moon 1 L.....	7 15 6,79	1,60
	l Geminorum	7 45 42,90	
3.	*l* Geminorum	7 45 41,07	
	Moon 1 L.....	8 22 42,37	
	δ Cancri	8 34 57,43	1,89
	A. S. C. 1098.....	8 49 30,52	
4.	*q* Cancri.....	9 9 23,32	
	Moon 2 L.....	9 31 21,44	2,20

III. On the Mass of *Jupiter*. By Professor Airy.

An account of this communication, the reading of which is not yet finished, will appear in the next Monthly Notice.

J. Moyes, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *April* 12, 1833. No. 20.

THE following communications were read:—

I. On the Mass of *Jupiter*. By Professor Airy.

"Next to the elements of the planetary orbits, the most important numerical value for the explanation and prediction of the phenomena of the solar system, is the mass of Jupiter. The great influence of this planet on the motions of *Saturn* was loosely pointed out by Newton; in *Halley's Tables* it was remarked that two successive periods of *Saturn* were found, from observation, to differ thirteen days; the small planets discovered in the present century are even more affected (in angular perturbation) by *Jupiter's* attraction; and, lastly, the motions of the comets of short period are changed in a still greater degree by his enormous perturbing force. The admission or rejection of the theory of the resistance of Encke's comet depended at one time upon the use of one or the other of the two values of *Jupiter's* mass, which were sanctioned by different authorities."

"With a full knowledge of this importance, it seems remarkable that no attempts should lately have been made to ascertain the correct value of *Jupiter's* mass, from the readiest of all means, the elongation of his satellites. It is true, that the value adopted by Laplace, $\frac{1}{1067\cdot09}$ of the sun's mass, (*Méc. Cél.* vol. iii. p. 72), was inferred from observations of the fourth satellite; but they were the observations which were made by Pound, and of which no account (so far as I know) remains, except the mere statement of numbers in the *Principia*. All the modern methods are comparatively indirect. Bouvard's was obtained from the perturbations of *Saturn*, as ascertained from modern observation (Introduction to his *Tables*), in the course of which (it may be remarked) the great inequality of *Saturn* depending on *Jupiter's* attraction is not particularly sensible. His numerical expression $\frac{1}{1070\cdot5}$ differed little from Laplace's. Nicolai, from the perturbations of *Juno*, found a value $\frac{1}{1053\cdot924}$, differing from Laplace's by $\frac{1}{80}$th part of the whole (*Berl. Jahrbuch*, 1826); and this discordance seems to have been the principal cause

of the question so much agitated among German astronomers;—Whether the absolute attraction of *Jupiter* on all bodies is the same? Encke (*Berlin Memoirs*, 1826) obtained from the perturbations of *Vesta* a value $\frac{1}{1050{\cdot}117}$, differing little from that of Nicolai; and Gauss, it is understood (for I am not aware that any account is published), has deduced the same, or nearly the same, from the perturbations of *Pallas*. Finally, the equations of condition from which the coefficient in the resistance of Encke's comet was determined (*Astronomische Nachrichten*, No. 210), served at the same time to correct the mass of *Jupiter;* and the value thus obtained, $\frac{1}{1054{\cdot}4}$, agrees very closely with that deduced from the perturbations of the three small planets."

"The best of the modern estimations thus conspiring to shew the inaccuracy of that which had been obtained from the observation of the satellites, it became a matter of great interest to inquire whether the difference proceeded from the defects of Pound's observations and theory, or from any physical difference in the action of *Jupiter* upon these two sets of bodies. Before the erection of the Cambridge equatorial (in the summer of 1832), I had determined, as soon as it should be fit for use, to make a series of observations on the fourth satellite for this purpose. My absence from Cambridge prevented me from making any observations till the month of September. In the course of that month, and the two following, thirteen sets of measures were obtained. The first of these was never calculated; I shall give good reasons for also rejecting the second and third (though, if retained, their effect on the result will be insensible); the remaining ten I believe to be as good as the nature of the observation admits of. The result as to the mass of *Jupiter* is highly satisfactory. The value thus obtained from the elongations of the fourth satellite agrees almost precisely with that obtained by Encke from the perturbations of *Vesta*, and cannot in any way be reconciled with that which was adopted by Laplace, and in some degree confirmed by the investigations of Bouvard."

"I shall endeavour to give means of estimating the accuracy of my result: in the mean time I may remark, that I consider it at least as accurate as those above quoted, for the following reason. Encke, after giving his own value, states that Nicolai's value would satisfy his equations nearly as well, and the numbers which I shall cite will prove the correctness of this remark. Now, for my equations Encke's value (with which mine may be considered coincident) is distinctly better than Nicolai's. A difference, therefore, which is not sensible in Encke's investigations, does appear to be sensible in mine."

"The detail of the observations will be found in the fifth volume of the *Cambridge Observations* for 1832."

The observations employed by Professor Airy for this investigation were differences of right ascension between the fourth satellite and the planet about the times of greatest elongation.

The distance of the fourth satellite from the body of *Jupiter* was in general great enough to admit of the transit observation being made at three wires; but sometimes only two were used. This operation was repeated twelve times; the instrument was then turned round 180°, and the same number of transits observed in the reversed position; and as the difference in declination between the two bodies was considerable, the declination circle being unclamped, was moved by hand, so as to use the same part of the wires in each case. It is obvious, that even if the axis of the declination circle be not truly perpendicular to the polar axis, the *mean* of results in reversed positions will be free from instrumental error arising from such a cause. In other respects the equatorial was sufficiently well adjusted; and the observations made on two days, when the former precautions were neglected, are omitted.

After explaining the mode of observation, and the reductions required for obtaining the true difference of right ascension, Professor Airy shews how the position and length of the radius vector of the satellite are found from the data of the *Mécanique Céleste;* "the length requiring, for its complete numerical expression, to be multiplied by the mean distance of the satellite from *Jupiter* (which at present is undetermined); from these the position and length of the projection of the radius vector on the earth's equator are found."

"The *Berliner Jahrbuch* gives the right ascension, declination, and log. distance of *Jupiter* from the earth. From these the position and length (expressed in terms of the earth's mean distance from the sun) of the projection on the earth's equator of the line drawn from the earth to *Jupiter* may be found. Knowing this, together with the difference of right ascension of *Jupiter* and the satellite, as observed at the earth, and the terrestrial right ascension of the satellite as seen from *Jupiter*, the length of the projection of the radius vector on the earth's equator is found, expressed by a multiple of the earth's mean distance from the sun.

"Comparing this with the former expression (which was a multiple of the satellite's mean distance from *Jupiter*), the mean distance of the satellite is immediately found, and thence the mass of *Jupiter*."

"I had at first no intention of correcting, or even examining the numbers of the *Mécanique Céleste;* but an examination simply for the verification of the typographical accuracy, led me to doubt the correctness of several of the numbers in page 94 of the fourth volume, and of those which depend on them. On further examination, I found that the variable terms, both of the radius vector and longitude, as far as I examined, were nearly correct; but that in the constant parts of the radius vector some terms were wrong in sign, one erroneous in magnitude, and one omitted. I corrected these, and then proceeded in the construction of my tables."

"In the first instance, however, to which I applied the calculations, I found, to my great astonishment, that, at the time when I had observed the satellite at extreme elongation, the tables repre-

sented it as between the earth and *Jupiter*. I satisfied myself that this was owing to no error in my own calculations, and I then compared Laplace's numbers with those of Halley and Delambre. From the tables of the former I could only infer that there was some very strange error in Laplace's epoch for 1750; from the mean conjunctions of the latter I could calculate its quantity. It will scarcely be believed, that the epoch of mean longitude in page 139 of the fourth volume of the *Mécanique Céleste* is erroneous to the amount of nearly one-third of the circumference, and that this is not a typographical error, as several numbers are combined with it by addition and subtraction in the pages following it, and all correctly. I confess that my faith in the *numerical* results of the *Mécanique Céleste* has been very much weakened by these discoveries."

"At the same time, I am far from imputing any negligence to the author of that great work; for I know too well the difficulty of insuring correction in long calculations from complex formulæ: and in some of the fundamental numbers of the present computations I was saved from error only by Mr. Lubbock's re-calculations."

A list of the errata in the *Mécanique Céleste* is appended to the memoir. The following are the individual results:—

1832.	Log. mass of ♃	Pos. 4th satellite.
Oct. 5	6·9811676	Following.
6	6·9808121	Following.
13	6·9764252	Preceding.
21	6·9814433	Following.
22	6·9828392	Following.
Nov. 1	6·9796958	Preceding.
10	6·9809291	Following.
16	6·9749036	Preceding.
17	6·9766625	Preceding.
25	6·9830216	Following.

"We see immediately that every determination from observations when the satellite *followed*, is greater than every determination when the satellite *preceded*. There are two ways of explaining this. One is by an error in the excentricity; for the satellite at its greatest elongations was very nearly at its apsides. But I do not ascribe the difference to this cause, but to an involuntary difference in the mode of observing the transits of a planet's limbs and a satellite's centre. I believe, in fact, that the difference of right ascension found from transits would not be the same as the difference determined by a double-image micrometer, or any similar contrivance. It is proper to state clearly, that before the commencement of the observations, I had distinctly contemplated the possibility of such a

difference, and had in consequence determined to observe the satellite, if possible, on both sides of the planet. It is plain that the effect of such an error is to alter the difference of right ascension in one direction by a constant quantity when the satellite follows, and to alter it by the same quantity in the opposite direction when the satellite precedes: the effect of an error in excentricity would be very nearly similar."

"Suppose, now, this constant error to be c, and the variable errors of the observations, beginning with October 5, to be e_1, e_2, &c. (all in multiples of $0^s{\cdot}001$ of time). When the satellite *follows*, as in October 5, we must suppose the observed right ascension to be too great by $(e_1 + c) \times 0^s{\cdot}001$; and when it *precedes*, as on October 13, we must suppose the observed right ascension to be too great by $(e_3 - c) \times 0^s{\cdot}001$. As the mass (at any given time) is nearly proportional to the cube of the difference of right ascension, we may conceive that on October 5 the log. mass is determined by adding some constant C to 3 log. (36·440). Thus we have

$$C + 3\log.(36{\cdot}440) = 6{\cdot}9811676.$$

But if x be the true log. mass,

$$C + 3\log.(36{\cdot}440 - \overline{e_1 + c} \times 0{\cdot}001) = x.$$

The difference gives

$$3\log.\left(1 - \frac{\overline{e_1 + c} \times 0{\cdot}001}{36{\cdot}440}\right) = x - 6{\cdot}9811676.$$

"It is easily seen that

$$3\log.\left(1 - \frac{\overline{e_1 + c} \times 0{\cdot}001}{36{\cdot}440}\right) = \frac{-1}{767{\cdot}5 \times 36{\cdot}440} \times \overline{e^1 + c} \text{ nearly},$$

(the number $767{\cdot}5 = \frac{1000}{3 \times \text{modulus}}$ being constant); hence we have

$$e_1 = -c + 767{\cdot}5 \times 36{\cdot}440 \times (6{\cdot}9811676 - x)$$

"Applying this process to the last ten observations, and putting $x = 6{\cdot}97 + y$, we get the following table of errors:—

$$\begin{aligned}
e_1 &= -c + 28000 \times (0{\cdot}0111676 - y)\\
e_2 &= -c + 30200 \times (0{\cdot}0108121 - y)\\
e_3 &= +c + 26000 \times (0{\cdot}0064252 - y)\\
e_4 &= -c + 23600 \times (0{\cdot}0114433 - y)\\
e_5 &= -c + 28300 \times (0{\cdot}0128392 - y)\\
e_6 &= +c + 26200 \times (0{\cdot}0096958 - y)\\
e_7 &= -c + 22000 \times (0{\cdot}0109291 - y)\\
e_8 &= +c + 26000 \times (0{\cdot}0049036 - y)\\
e_9 &= +c + 26600 \times (0{\cdot}0066625 - y)\\
e_{10} &= -c + 26500 \times (0{\cdot}0130216 - y)
\end{aligned}$$

"The difference in the accuracy of the different observations I conceive to be very small; for though some comprehended a

greater number of wires than others, the former were in general rather more hurried than the latter. Considering all equal in accuracy, and taking the sum of the squares of the errors, we find that it may be put in this form,

$$6986140000\left\{x + 0{\cdot}00000770096 \times c - 6{\cdot}9793374\right\}^2$$
$$+ 9{\cdot}58569\left\{c - 62{\cdot}9112\right\}^2$$
$$+ 12179{\cdot}1$$

" To make this a minimum with regard to c, it is plain that we must put $c = 62{\cdot}9112$; or the constant error in the difference of transits $= 0^s{\cdot}063$. The expression for the sum of the squares of errors then becomes

$$6986140000\left\{x - 6{\cdot}9793529\right\}^2 + 12179{\cdot}1$$

The value of x which makes this least is 6·9793529; and this is therefore the value which I adopt, subject to some very small corrections, to be mentioned hereafter. The number corresponding to this logarithm is $\frac{1}{1048{\cdot}69}$.

" To shew the reliance which can be placed upon this determination, I shall exhibit the amount of the sum of squares produced by the substitution of this and of other values of the log. mass."

" The value above gives 12179·1, whence the mean value of the square of an error is 1217·91; or the mean error of a difference of right ascension (independent of the constant error) $0^s{\cdot}035$."

" Encke's value of the log. mass is 6·9787626, which gives for the sum of squares 14613·0; or the mean error of a difference of right ascension $0^s{\cdot}038$."

" Nicolai's value is 6·9771907, which makes the sum of squares 44839·3; or the mean error of a difference of right ascension $0^s{\cdot}067$."

" Laplace's value is 6·9717989, which makes the sum of squares 410828·5; or the mean error of a difference of right ascension $0^s{\cdot}203$."

" It is here evident that Encke's value satisfies the observations nearly as well as mine, but that Nicolai's value by no means satisfies them so well; the sum of the squares of errors being more than three times as great as that given by Encke's, and nearly four times as great as that given by mine. Laplace's value is clearly incompatible with my observations."

" The preference of Encke's value to Nicolai's is much more distinctly marked here than in Encke's original investigations; the sum of the squares of the errors in the observations of *Vesta* was 59·65 with Encke's mass, and only 65·68 with Nicolai's mass. As far, therefore, as those observations went, Encke was justified in saying that Nicolai's mass satisfied them very nearly as well as his own, and that there was no sufficient reason for adopting his value in preference to Nicolai's. Here, however, the case is quite dif-

ferent; and we may assert, without hesitation, that Nicolai's mass cannot now be admitted, but that Encke's mass is nearly as well supported as mine by these observations."

"If the assumption of a constant error (changing its sign according as the satellite preceded or followed) were rejected, the expression for the sum of squares would be

$$6986140000\left\{x - 6{\cdot}9798374\right\}^2 + 50117{\cdot}5$$

The alteration in the value of the mass which makes the sum of squares a minimum, is very trifling. The values of the sum of squares and the mean error are now,

With my mass above	51757·1	and 0ˢ·072
With Encke's mass	58187·1	and 0ˢ·076
With Nicolai's mass	99055·4	and 0ˢ·100
With Laplace's mass	501544·5	and 0ˢ·224

"I have given these only to shew that the decided preference of Encke's mass to Nicolai's depends very little on the assumption of a constant error. It is, however, merely a matter of curiosity; for no one, I believe, will deny the certainty of the constant error in these observations. I may add, that as I have been accustomed to consider the error of a transit over seven wires as not greater than 0ˢ·06, when made under favourable circumstances, I may safely estimate the difference of right ascension, determined by passages over twenty-four or thirty-six wires (all which were chosen observations, unsatisfactory observations having been rejected at once), as perhaps liable to a mean error of 0ˢ·035, but certainly not liable to one of 0ˢ·067 or 0ˢ·072."

After applying two small corrections, one for the clock rate during the observations, and the other for obtaining the whole mass of the Jovial system, Professor Airy concludes, that we have for the log. mass of the Jovial system 6·9793486, and for the mass $\frac{1}{1048{\cdot}70}$."

"In conclusion I may remark, that I do not think this value liable to any serious error, except from a possible error in the inclination of the orbit of the fourth satellite. The effect of the greatest error of the instrument in azimuth (0′·5) that any observations have shewn, acting at the greatest disadvantage, would not alter the denomination of the fraction by 0·2. But the observations used here have been made when *Jupiter* was in the most unfavourable of all positions, both from the effect of such errors, and from the smallness of the difference of right ascension, which is the immediate subject of the measures. The oppositions of 1834-5 and 1836 will be very much more favourable."

"I am far from regarding the question as definitively settled by these measures; and I offer these results to the Society as only the first fruits of my investigations. Should the regular [redacted] of the Observatory, and my other employments, [redacted]

leisure, I hope to add considerably to their number. The necessary tables and forms of calculations are prepared; some theoretical and numerical difficulties have been surmounted; and the labour of calculating future observations will therefore be very much less than that of calculating the first."

II. On a Method of determining the Longitude with considerable accuracy by means of Lunar Eclipses. By Captain Henry Kater, F.R.S.

The author remarks that eclipses of the moon have hitherto been of but little use in the determination of terrestrial longitudes, on account of the uncertainty attending the observation of their commencement and termination. And although it has been proposed to observe the times when the earth's shadow touches certain spots upon the moon, yet it is evident that for the purpose of deducing the longitude from such observations, not only two observers are necessary, but they must also previously agree upon the particular spots to be observed. This mode, therefore, promises but little practical utility.

The method which the author here details enables the observer to deduce, with considerable accuracy, the time of the middle of the eclipse. It consists in taking numerous measures of the enlightened segment with a micrometer, near the commencement and end of the eclipse, noting the corresponding times. It is evident that by taking the mean of the times corresponding to any two equal segments near the beginning and end of the eclipse, the time of the middle will be obtained as accurately, if not more so, than it would have been if deduced from observations of the beginning and end of the eclipse made in the usual manner. And by taking the mean of many similar deductions of the middle of the eclipse, a result will be obtained approximating very nearly to the truth.

Captain Kater says, " I was not aware until lately that I have been in some measure anticipated by a suggestion of this method by M. La Lande, who says, in his *Astronomie*, ' On observe aussi les phases, ou les segmens éclairés, par le moyen du micromètre, pour déduire le milieu par deux phases égales.' I cannot, however, find that his suggestion was ever put in practice."

" The observations given in this paper were made merely with a view to determine the amount of the greatest obscuration, and consequently I did not begin my measurements until long after the commencement of the eclipse, and they were discontinued some time before its termination. In addition to which, they were not made with all the care that might have been bestowed upon them. It will therefore be seen, that the example I am about to give is nearly as unfavourable as can well be imagined. The accuracy of the result, under such circumstances, is the best proof of what may be expected from observations made with an express view to the object in question."

The author then states the result of forty-five micrometrical

measurements made by him at Union Place, during the lunar eclipse of August 2d, 1832: amongst which he selects several made after the middle of the eclipse, of nearly equal magnitude with others made prior thereto. Combining such similar measures, he thence deduces, from the mean of all the combinations, the middle of the eclipse, as shewn by the clock used in the observations.

By taking the difference between the computed mean time of the middle of the eclipse at Greenwich, and the observed mean time of the middle of the eclipse at Union Place, he obtains the longitude of Union Place from Greenwich as follows:

Longitude by each pair of measurements.	Error.	Number of obs.	Longitude by the mean.	Error.
m s	m s		s	s
W. 0 9,26	−0 26,94	1	W. 9,26	−26,94
E. 0 6,74	−0 42,94	2	1,26	−34,94
W. 1 52,26	+1 16,06	3	38,26	+ 2,06
1 9,26	+0 33,06	4	46,01	+ 9,81
0 25,26	−0 10,94	5	41,86	+ 5,66
0 4,26	−0 31,94	6	35,60	− 0,60
0 24,26	−0 11,94	7	33,98	− 2,22
0 53,26	+0 17,06	8	36,39	+ 0,19
1 58,26	+0 22,06	9	45,49	+ 9,29
1 1,26	+0 25,06	10	47,06	+10,86
1 18,26	+0 42,06	11	49,90	+13,70
1 2,26	+0 26,06	12	50,93	+14,73

" In the above table, the first column contains the longitude deduced from each pair of measurements; the second column, the error or difference of each result from the true longitude; the third column, the number of separate determinations of the time of the middle of the eclipse, the mean of which has been taken in determining the longitude, and which resulting longitude is given in the fourth column; the fifth column contains the error or difference of each mean from the true longitude."

" On considering the fifth column, containing the errors of the longitude deduced from the mean of several observations, it may be seen that when the mean of more than five results is taken, the error of the deduced longitude is very small; and it does not appear necessary to take the mean of more than seven or eight results, to obtain a near approximation to the truth. In the present instance, the last four or five means include observations made too near the middle of the eclipse to be relied upon, for it must be obvious that those made near the commencement and termination will give by far the most accurate results."

" It seems, then, that if we take the mean of the first six, the first seven, and the first eight results, the respective differences of

the deduced longitude from the truth would be $-0^s,6$, $-2^s,2$, and $+0^s,19$; and it is very probable that had the observations been made near the beginning and end of the eclipse, instead of so near the middle, the error of the resulting longitude would have been confined within very narrow limits."

"It is unnecessary to enlarge on the advantages which this method presents. It may be readily practised at sea by using a sextant: for this suggestion I am indebted to Captain Beaufort. It frequently happens that neither the beginning nor end of an eclipse can be observed, yet, as in the present instance, the time of the middle of the eclipse may, notwithstanding, be determined. It can rarely happen that only one pair of measurements of the luminous segments can be taken, yet even in that case it is probable that the longitude would be obtained, as may be seen by the above table, much within one minute of the truth, which is far within the limits of the errors assigned by different writers to observations made in the usual manner. But when the mean of a number of deductions of the middle time of the eclipse is taken, it should seem that it would be difficult to limit the degree of accuracy which it might be possible to attain."

As an eclipse of the moon will take place on the 1st of July, observers will have an opportunity of trying the efficacy of this method.

III. Planetary Observations made at the Observatory of Wilna. By M. Slavinski.

These observations, which are lithographed, consist of right ascensions and declinations of *Uranus* in 1829, and of *Mars*, *Jupiter*, *Uranus*, and *Vesta*, in 1830. The stars of comparison were all reduced by the Astronomical Society's Catalogue. The maximum, minimum, and mean heights of the barometer and thermometer for every month of the two years during which the observations were made, are annexed.

IV. A letter from the Rev. W. R. Dawes to Mr. Dollond, on an improvement in the Micrometer by the latter. Communicated by Mr. Dollond.

Mr. Dawes expresses a highly favourable opinion of Mr. Dollond's improvement, from the results of his own observations; but as the particulars of that improvement have not yet been communicated to the Society, the details of this paper are deferred till further information is received on the subject.

V. Observations, &c. made at Padua, from the year 1829 to 1832, inclusive. By M. Santini.

These observations comprise, 1st, Occultations of *Aldebaran* and other stars; 2d, the transit of *Mercury*, occultation of *Saturn*, and eclipse of the sun of 1832; 3d, Observations of the comet discovered by M. Gambart, July 19, 1832, and of Biela's comet. These latter observations have been given in the Monthly Notice for December 1832, in a communication from Professor Airy.

VI. Observations made at Saville Row. By Mr. Snow.

These observations comprise, 1st, Right ascensions of *Mars*, and of stars observed with *Mars*, in November and December 1832; 2d, Mean right ascension of 60 unknown stars for 1832; 3d, Observations of the egress of *Jupiter's* satellites on Dec. 26, 1832, made for the purpose of ascertaining if the phenomena could be observed with sufficient accuracy, agreeably to the recommendation of the superintendent of the *Nautical Almanac*.

" Dec. 26, 1832. Egress of first satellite at $23^h\ 12^m\ 40^s$ sidereal time. (Corrected for clock error.)

" At this point of time the satellite was just adhering to the edge of *Jupiter's* disc: but it had been distinguishable since $23^h\ 9^m$, or about 4^m sooner.

" The egress of the shadow of the first satellite could not be observed with any thing like accuracy with the instrument in question, for the shadow fell in the middle of the broad belt of *Jupiter:* clouds came over, too, at the time of the egress.

" The second satellite, which was set down as emerging at $1^h\ 16^m$ sidereal time, never emerged at all; at least, not before 3^h sidereal time, up to which time it was watched for continually without success.

" The third satellite disappeared finally at $2^h\ 19^m\ 0^s$, sid. time (corrected for clock error), pretty exactly. It was in contact with the limb of the planet 5 minutes before I lost sight of it. Telescope 42-inch refractor, power 120, which was found to succeed with *Jupiter* better than any other power; but the evening was so fine, that the telescope shewed *Jupiter* very well with a power of 300."

J. Moyes, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *May* 10, 1833. No. 21.

THE following communications were read:—

I. On the Latitude and Longitude of the Cape Observatory. By Mr. Henderson.

"Mr. Fallows, from his observations made with Jones's 6-feet mural circle, reckoned the latitude of this observatory to be 33° 56′ 4″ south. From my own observations made with the same instrument, I find the angular distance between the south polar and horizontal points, measured upon the limb of the circle, or the latitude, to be 33° 56′ 2″,8. The polar point was determined by observations of the circumpolar stars, whose positions are given in the accompanying paper; the horizontal point by observations of various stars on both sides of the zenith, made by direct vision and by reflexion from the surface of quicksilver. This quantity may be found to require a small correction, when the whole of the observations, as well those already made as those still to be made, are properly reduced and combined together. In the mean time, the latitude which I have stated may be safely adopted for almost every purpose. Mr. Fallows reduced his observations by Dr. Young's refractions. The table which I have employed is Bessel's, contained in the *Tabulæ Regiomontanæ*.

"For the determination of the longitude, Mr. Fallows, in the course of the years 1829 and 1830, made a great many observations of the transits of the moon and adjoining stars with Dollond's 10-feet transit instrument. These I have compared with the corresponding observations of both limbs of the moon made at European observatories."

Difference of Longitude between Greenwich and the Cape.

23 observations of 1st limb ...	1^h	14^m	$0^s,9$	Mean diff. of observations	$\pm 7^s,2$
6 ..... 2d limb ...	1	13	51,3	.....	$\pm 5,0$
	1	13	56,1	Cape, east of Greenwich.	

. . . . . *Cambridge and the Cape.*

14 observations of 1st limb ...	1^h	13^m	$35^s,1$	Mean difference	$\pm 5^s,8$
2 ..... 2d limb ...	1	13	27,9	.....	$\pm 0,5$
	1	13	31,5	Cape, east of Cambridge.	

Difference of Longitude of Abo and the Cape.

15 observations of 1st limb ...	0^h	15^m	$8^s,3$	Mean difference	$\pm 4^s,1$
4 .... 2d limb ...	0	15	12 ,2	.....	$\pm 1,0$
	0	15	10 ,2	Cape, west of Abo.	

Edinburgh and the Cape.

12 observations of 1st limb ...	1^h	26^m	$37^s,2$	Mean difference	$\pm 4^s,8$
3 ..... 2d limb ...	1	26	37 ,3	.....	$\pm 1,8$
	1	26	37 ,2	Cape, east of Edinburgh.	

Hence we have the longitude of the Cape, east of Greenwich,

Place.	Long. of Cape from that place.	Assumed Long. of place from Greenwich.	Long. of Cape.
By Greenwich			$1^h\ 13^m\ 56^s,1$
Cambridge ...	$1^h\ 13^m\ 31^s,5$	$+0^h\ 0^m\ 23^s,5$	= 1 13 55 ,0
Abo	$-0\ 15\ 10\ ,2$	$+1\ 29\ 8\ ,8$	= 1 13 58 ,6
Edinburgh ...	1 26 37 ,2	$-0\ 12\ 43\ ,6$	= 1 13 53 ,6
		Mean	1 13 55 ,8
		Or, in degrees ...	18° 28′ 57″

" It is not to be expected that subsequent investigations will materially alter the above result. I assume the geographical position of the Cape observatory to be 33° 56′ 3″ south latitude, $1^h\ 13^m\ 56^s$ east longitude, from Greenwich."

" It would be interesting to ascertain trigonometrically the distance betwixt this observatory and the known site of La Caille's in Cape Town. The longitude assigned by La Caille to his observatory, $1^h\ 4^m\ 18^s,5$ east of Paris, and that computed by Encke from the observations of La Caille, Mason, Dixon, Wales, and Bayley, $1^h\ 4^m\ 20^s$ east of Paris, or $1^h\ 13^m\ 40^s$ and $1^h\ 13^m\ 41^s,5$ east of Greenwich, agree remarkably well with the distance of this observatory from Cape Town,—about three and a half miles, in the direction of east by south."

" The hill and elevated land at the extremity of the Cape peninsula, forming the headland to which has been assigned the celebrated appellation of ' The Cape of Good Hope,' lie in the direct meridian of the observatory, and are visible from the immediate neighbourhood; but owing to the intervention of rising ground covered with trees, we have not been able to see them from the building. The hill overhanging the other headland, named ' False Cape,' or ' Hanglip,' is, however, visible from the observatory, but no part of the intervening sea named ' False Bay' can be seen, as the view is intercepted by the flat sandy downs of the Cape isthmus. Lieutenant Meadows, from observations made with a reflecting sextant, has determined the azimuth of False Cape to be 33° 57′ east of the meridian of the observatory. Assuming the latitude of the hill over False Cape to be 34° 22′½, as laid down in Captain Owen's chart (the latitude of Cape Point or the Cape of Good Hope being 34° 22′ by the same excellent authority), it follows that the difference of longitude between the observatory and False Cape is 21′ 30″

of space. Hence the longitude of the two Capes may be stated as follows:—

Cape of Good Hope	18°	29′	0″	
False Cape	18	50	30	east of Greenwich.

" This longitude of the Cape Point differs only one mile from that given by La Caille (16° 10′ east of Paris—*Memoirs of Academy of Sciences* for 1751, p. 425); and it is but justice to the memory of that distinguished astronomer to remark, that the lapse of eighty years, and the superior means which the present state of the science affords, have not been able to produce any improvement in the geographical position of this part of the world, as determined by him."

II. Positions of Stars near the South Pole, from Observations made at the Observatory at the Cape of Good Hope. By Mr. Henderson.

" It is well known that there is no conspicuous star near the South Pole, which can be observed in the day-time, even with the most powerful meridian telescopes that are used in observatories. In this respect astronomers in the southern hemisphere are not so fortunate as their northern brethren, who, in the stars α and δ *Ursæ Minoris*, possess two celestial objects that are admirably adapted for determining the polar positions of their instruments, not only from their visibility by day, but from their places having been correctly ascertained from numerous observations made in the first observatories.

" In the southern hemisphere it becomes necessary to have recourse to stars of lesser magnitude, and even to increase their number, in order that one or more of them may pass the meridian at a convenient time of the night. Since my arrival at this observatory, in April last, seven circumpolar stars have been frequently observed with Dollond's 10-feet transit telescope, and Jones's 6-feet mural circle, for the purpose of determining the positions of these instruments with regard to the Pole: and the observations above and below the Pole having been compared together, the places of the stars have been already determined with a considerable degree of accuracy; and though it may be expected that subsequent observations will produce small changes in the calculated value, yet, in their present state, I believe that they may be of considerable use to astronomers; and I therefore take an early opportunity of communicating them.

" The following is a catalogue of the mean positions of these stars, reduced to the beginning of 1832 (fictitious year of the Astronomical Society's Catalogue). In the reductions, the co-efficient of aberration was assumed to be 20″,5; the other elements of reduction are the same as in the Society's Catalogue. The columns entitled " annual change" denote the annual variations which take place in the yearly precessions, and which, being applied according to their signs to the precessions for the beginning of 1832, as in the

catalogue, give the yearly precessions for the beginning of 1833; and hence the catalogue may be carried on for a few years with tolerable accuracy. The columns entitled "mean difference" exhibit the means of the differences of the results of the single observations from the mean of the whole, and are intended to shew the probable accuracy of the determinations.

Positions of Stars near the South Pole for the beginning of 1832.

Stars.	Magnitude.	Right Ascension.					Declination.					
			Annual Precession.	Yearly change.	Number of Observations.	Mean Diff.		Annual Precession.	Yearly change.	Number of Observations.	Mean Diff.
		h m s	s	s		s	° ′ ″	″	″		″
o Octantis	6·7	0 14 45·7	− 3·94	+0·087	3 above 6 below	2·5	−89 17 49·8	+20·00	0·000	3 above 8 below	0·7
* Octantis	7	8 36 45·5	− 33·15	−0·155	9 above 9 below	1·1	−88 21 44·9	−12·66	+0·035	14 below	0·5
π Octantis	7	14 14 13·5	+ 19·56	+0·064	6 above 2 below	0·9	−87 26 11·2	−16·70	+0·015	10 above 1 below	0·5
σ Octantis	6	16 58 31·2	+101·86	+0·394	24 above 2 below	2·5	−89 15 9·3	− 5·31	+0·143	25 above	0·7
* Octantis	7	19 31 44·5	+164·10	−1·570	26 above 4 below	3·8	−89 33 42·8	+ 7·81	+0·220	18 above	1·0
* Octantis	7	21 56 41·4	+ 15·36	−0·045	6 above 9 below	0·3	−86 48 32·7	+17·21	+0·010	5 above 2 below	1·0
τ Octantis	6	22 58 13·7	+ 15·81	−0·098	5 above 5 below	1·2	−88 23 59·4	+19·32	+0·006	10 above 9 below	0·9

III. Various observations made at the Cape Observatory.

1. Observed right ascensions of the moon and stars, 1832, April 10 to October 17, inclusive; chiefly by Mr. Meadows. The clock errors depend upon the mean right ascensions of Bessel's fundamental stars contained in the *Berlin Ephemeris*, reduced to apparent right ascensions, with aberration 20″,5; lunar nutation 9″,25.

2. Observations of the moon and stars, made with the mural circle by Mr. Henderson, for the determination of the moon's parallax. 1832, July 20, to January 2, 1833.

3. Observations of *Mars* and stars, made with the mural circle, for the determination of the parallax of *Mars*, by Mr. Henderson, 1832, October 3 to November 25, inclusive. The readings of the zenith point of the instrument, during that period, are subjoined.

4. Eclipses of *Jupiter's* satellites, 1832, April 12 to October 19, compared with the computed times in the *Nautical Almanac*, regard being had to Mr. Jenkins's corrections; by Messrs. Henderson and Meadows.

5. Occultations of planets and fixed stars by the moon, 1832, August 10 to October 31; by Messrs. Henderson and Meadows.

6. Transit of *Mercury*, May 4 and 5, 1832; and micrometrical observations of the same with a divided object-glass, by Messrs. Henderson, Meadows, and Fayrer; with the longitude resulting from a comparison with the observations of the astronomer royal.

IV. On the Solar Parallax. By Mr. Shires.

V. On the determination of the true heights of distant mountains from their apparent elevations above the sea. By G. Blackburne, B.A.

The object of this investigation is to furnish a convenient formula for the computation of the terrestrial refraction in terms of the distance of the observer from the object and the apparent elevation; and secondly, for the computation of the true height of the object itself. Mr. Blackburne supposes that two observations have been made of the angle subtended by that part of the mountain which is visible above the sea horizon, at two stations, and that the distance of each from the foot of the mountain is known. He finds two expressions for the height in terms of the apparent altitude, distance, dip, and terrestrial refraction at each station, and, by equating these values, obtains an expression for the terrestrial refraction. If ϱ be the terrestrial refraction, D and D′ the two distances, α and α' the visible altitudes, δ the dip of the horizon, and r the earth's radius, then

$$\sin \varrho = \frac{D\left\{(D+D'-2\delta).(D-D') - 2r\,(D'.\sin\alpha' - D\sin\alpha)\right\}}{2r.(D+D'-\delta).(D-D').}$$

It is evident that the two distances must be *unequal*.

The true altitude of the mountain is easily found from either of the observations, when the terrestrial refraction is known.

If the true altitude were previously known, the terrestrial refraction might be found from the observed altitude at one station, the distance of which from the mountain is also known. In this case,

$$\sin \varepsilon = \frac{(D-\delta)^2 + 2rD \sin \alpha - 2rH}{2r \cdot (D-\delta)},$$

where the symbols have the same signification as before.

J. Moyes, Castle Street, Leicester Square.

ROYAL ASTRONOMICAL SOCIETY.

VOL. II. *June* 14, 1833. No. 22.

THE following communications were read:—

I. Observations of Biela's Comet, from Nov. 18, 1832, to Jan. 3, 1833. By T. Henderson, Esq., Astronomer at the Cape of Good Hope.

These observations were made with a telescope by Dollond, of 45 inches focal length, and $3\frac{1}{2}$ inches aperture, power 30; and a circular micrometer by Simms, with a radius of 1015 seconds of arc.

The comet was looked for on the 18th of November, when it had just entered the southern hemisphere, and was immediately seen in the place given in the Supplement to the *Nautical Almanac*.

The places of the comet were obtained from comparison with various stars, the approximate places of which are given, and which were in course of observation when the paper was written. The comparisons are corrected for the comet's parallax and motion, but not for refraction; the latter quantity being much less than unavoidable errors of observation.

The comet became invisible after Jan. 3, owing to the increasing moonlight. After the lapse of a fortnight, when the moonlight was gone, it could not be seen, though carefully looked for.

II. Various Observations made at the Observatory of the Cape of Good Hope. Communicated by T. Henderson, Esq.

1. Observed transits of the moon and moon-culminating stars, from Nov. 3, 1832, to April 13, 1833. By Lieut. Meadows, R.N.

2. Observations of the moon and stars made with the mural circle, from March 4 to April 3, 1833.

3. Observed eclipses of *Jupiter's* first and second satellites, from Nov. 9, to Dec. 25, 1832.

4. Observed lunar occultations, from Nov. 10, 1832, to April 2, 1833.

This series of observations made at the Cape Observatory by Messrs. Henderson and Meadows, is a continuation of those already communicated. (See *Monthly Notice* for May 1833.)

III. Observations of *Mars*, and stars observed with *Mars*, near the Opposition, between Oct. 14 and Dec. 22, 1832, at the Observatory, St. Helena. By Lieut. Johnson.

These observations were made with the mural circle, and are corrected for refraction and instrumental errors, the former by Dr. Young's table.

IV. Observations of the Magnitude, Colour, and Brightness of Stars in the Southern Hemisphere. By James Dunlop, Esq., Astronomer at Paramatta.

This paper contains determinations by Mr. Dunlop of the size or apparent diameter of the disc of several stars, by means of the double-image eye-piece. A scale of magnitudes being thus obtained, he has viewed and carefully noted the appearance of about 400 southern stars, specifying the character of each under the heads of magnitude, lustre, and colour. Individual comparisons between neighbouring stars are frequently given, which will enable observers to discover any changes that may hereafter occur.

V. Observations of several Meridian Transits of the Moon. By the Rev. M. Ward.

These observations were made with a view of calling the attention of astronomers to the question whether meridian transits of the moon, in the present improved state of the *Nautical Almanac*, might not give the longitude in time with a precision not greatly inferior to other methods.

VI. Observations of Occultations and Eclipses made in the year 1832, at Biggleswade, with the Wollaston Telescope. By T. Maclear, Esq.

On the power of the telescope Mr. Maclear remarks, " power 130 seems to be the best for observing the eclipses of *Jupiter's* satellites. At immersion, even the first satellite is first seen as a very fine point, and sometimes with the second satellite 40 seconds elapse before it is visible to another observer with a 30-inch telescope."

VII. Description of a small Observatory erected at Biggleswade. By T. Maclear, Esq.

The Memoirs will contain the full description of Mr. Maclear's observatory. As the detailed explanation would be of little service, unaccompanied by the designs, we can here only state, that it consists of a transit-room, and of one with a revolving dome for the telescope. The clock in the former is supported, independently of the case, by stone brackets, projecting from a stone pillar. The telescope-room is built of wood, of an octagonal form, and the dome is hemispherical, the opening extending from the zenith to the horizon, with a sliding shutter easily opening in whole or in part, so that the dew can be kept off the object-glass. The telescope is supported on a solid oak plank, of 18 inches diameter, three feet in the ground and five out of it. This answers as well as brick-work; and Mr. Maclear has not found the slightest tremor

even in high winds. The total expense of this room was fifty pounds.

VIII. An Approximate Method of finding the Latitude from two Altitudes observed near the Meridian, with the interval of time. By Lieut. Raper.

The object is to obtain the meridian altitude from these elements, without knowing either the absolute apparent time, or whether the altitudes are both observed in the same or different sides of the meridian.

The problem is considered as a question of differences; and the second difference of altitude, supposed constant, is computed, for this particular purpose, from the expression

$$\Delta^2 u = 15 \times 2 \frac{\sin p \cos l}{\cos a} \sin \frac{\Delta P}{2} \cdot \Delta P;$$

u being the altitude, p the polar distance, l the latitude, a the lesser altitude, and ΔP the interval or difference of time. The errors of the process are such as partially to compensate each other, and the method holds good to about one hour on both sides of the meridian, that is, the interval may be any time from five minutes to nearly two hours in these latitudes, and less than one-third of these limits in low latitudes.

1. When the time from noon (in the case of the sun) exceeds the interval, the second difference being continually subtracted from the difference of altitudes, and the remainders added to the greater altitude, gives the meridian altitude near enough for sea purposes, when the interval is small.

2. When the interval exceeds the time from noon, the addition to the greater altitude is

$$\frac{(\Delta u - \frac{1}{2}\Delta^2 u)^2}{\Delta^2 u};$$

which also serves to correct the process in the first case, when the interval is large.

3. When the sun has crossed the meridian in the interval, one-eighth of the second difference is a correction, which, added to the mean of the two altitudes, gives the altitude at the middle time: the mean of this altitude, and the greatest, increased by one-fourth of the former correction, is the altitude at the next subdivision, and thus the meridian altitude is quickly converged to.

These three cases will commonly declare themselves in practice; but if a case is doubtful, it can be very simply discovered which it is.

By this principle of solution the errors of observation do not affect the results in the same manner as they do the solutions by spherical trigonometry.

IX. Notice of the Elliptic Orbit of ξ *Boötis*, with a further Approximation to the Orbit of γ *Virginis*. By Sir John Herschel.

The elements of the orbit of ξ *Boötis* are given for the first time; those of γ *Virginis* are recalculated by the aid of observations made in the current year, by Sir J. Herschel and others, which differ materially from the *Ephemeris* published in the Supplement to the *Nautical Almanac* for 1832. Comparisons of the calculated results, with observations, are given in both cases.

The elements are as follow:—

ξ *Boötis.*

Semiaxis major	$a = 12''{\cdot}56$	Inclination to the plane of the sky	$\gamma = 80° 5'$
Excentricity	$e = 0{\cdot}59374$	Position of node	$\Omega = 359° 59'$
Pos. of perihelion ...	$\varpi = 138° 24'$	Period in tropical years.....	$P = 117{\cdot}14$
Angle between lines of nodes and apsides	$\lambda = 100° 59'$	Mean motion	$n = -3°{\cdot}0733$

Perihelion passage, Dec. 17, 1779.

"These elements are interesting in several respects. In the first place, the period they indicate fills up an intermediate and wanting link between the short periods of η *Coronæ*, ξ *Ursæ*, &c. and the much longer ones of *Castor*, σ *Coronæ*, 61 *Cygni*, γ *Virginis*, &c. establishing (so far as we can at present rely on such determinations) a connected scale of periods, from less than half a century to upwards of six centuries. The great amount of the excentricity of the orbit in question strengthens the induction which already begins to assign, in no unequivocal manner, orbits rather of a cometary than a planetary character to the binary stars generally. This orbit, moreover, is the most oblique to the line of sight which has yet been calculated; and as the apparent position of the projected perihelion is not very far from making a right angle with the line of nodes, the longer axis of the real ellipse is violently foreshortened, and the whole character of the apparent ellipse completely distorted, as seen in projection, from what it is in reality."

γ *Virginis.*

Major semiaxis	a	$= 12''{\cdot}090$
Excentricity	e	$= 0{\cdot}8335$
Perihelion projected	ϖ	$= 36° 40'$
Perihelion from node on the orbit.....	λ	$= 282° 21'$
Inclination to heavens.....	γ	$= 67° 2'$
Node.....	Ω	$= 97 23$
Period in tropical years	P	$= 628{\cdot}90$
Mean annual motion	n	$= -0°{\cdot}57242$
Perihelion passage	τ	$= 1834{\cdot}63$

X. On the Adoption of a Standard of Optical Power by Observers. By the Rev. W. R. Dawes.

"Almost from the first invention of telescopes to the present day, the eclipses of *Jupiter's* satellites have afforded matter of interest to the astronomer, and to all who are anxious for the improvement of geographical science. Unhappily, however, notwithstanding all which has been done to improve this most simple method of determining differences of terrestrial longitude, there are few observa-

tions whose results are less satisfactory. Nor will this excite surprise, if it be considered, that the instant when any of these phenomena is observed is greatly influenced by the circumstances under which it is witnessed. When observed at different places, the results may be affected by diverse states of the atmosphere, and altitudes of the planet; besides the varieties existing in the *instruments* employed, and the *eyes* which use them. But though it is beyond our power to control the state of the atmosphere, or to alter the situation of the planet, we may, I conceive, do much to remove the enormous discrepancies arising from the differences in the optical power and acuteness which are brought to bear on this interesting class of phenomena.

"It might be supposed, perhaps, that a sufficient agreement of optical power might be obtained by fixing on a certain aperture, and a suitable magnifying power, as a standard to be adopted by all observers who are desirous of determining differences of longitude by means of these eclipses. And, no doubt, a much nearer approach to what is desirable would be thus obtained, than can be expected while some are employing telescopes possessed of immensely greater illuminating power than those used by others for the same purpose. However important in other respects observations may be, made in well determined stations, with large instruments, they are obviously not comparable with the results obtained by such instruments as are usually possessed by private individuals of astronomical taste, and to whom this species of observation is commonly very interesting, and would be more so were its results less unsatisfactory. Yet, were we to agree to cut down the larger instruments to a certain aperture, we should still leave two sources of disagreement unprovided against, which however are within our control. First, the instruments thus *apparently* placed on a footing would differ much in excellence, and consequently in the time when they would render an immerging or emerging satellite only just visible. Secondly, even could this point be adjusted, there would remain the very great variety which exists in different individuals in respect of *acuteness of vision*. This I believe to be much greater than is generally supposed; for I know it to be such, in some instances, as to render the 42-inch achromatic telescope as efficient an instrument to one observer, in discerning minute points of light, as a 5-feet achromatic is to another; each instrument having its usual aperture, and being of corresponding excellence. In further proof of this, I may advert to the fact, that in every instance in which Captain Smyth and myself have witnessed the same *emersion*, the satellite appears to have been first discerned by me; the instrument used at Bedford being, as I understand, the excellent 8½-feet achromatic of nearly 6 inches aperture, and consequently possessing an illuminating power of between two and three times greater than that of my 5-feet achromatic. Hence it is manifest that some plan must be devised for equalising the optical powers of the different *observers and their instruments*, the *eye* and the *telescope* being viewed as one compound optical machine. And

this being attained, the varying condition of the atmosphere would alone be uncontrollable; for I imagine the differences of the planet's altitude might be very nearly allowed for by a corresponding alteration in the aperture or power generally used.

"I would therefore earnestly recommend the adoption of some celestial object as a *standard* of the optical power to be employed; and I know of none possessing so many advantages as the minute companion of *Polaris*. It is readily found, is visible throughout the year, and preserves nearly the same altitude. Let each observer then ascertain, by a series of experiments on several clear nights, what is the *minimum aperture* with which his instrument will enable him, on an average of such nights, to keep this delicate object *just steadily* in view. Perhaps it would be proper to fix the power employed at about 80. This power is very usually attached to the 3½-feet achromatic, the aperture of which instrument will, I imagine, to most eyes, admit of a little diminution to bring it to the proposed standard. This telescope is, moreover, not an uncommon one among observers; yet I am disposed to regret, that the object I have selected as on the whole the best, is not sufficiently visible with the usual 30-inch achromatic. For, the greater the number of observers engaged, the more interesting and useful are the results likely to prove.

"It appears to me, that by the adoption of this plan, all the observers of these phenomena would be placed as nearly as possible on an equal footing, and every source of uncertainty within our control would be removed. I am not, indeed, prepared to suggest precisely the best mode of meeting the differences of the planet's altitude, as seen from different places; but this will not vary enormously in the British Isles; and if the plan should meet with the approbation of observers within these limits, and by them be subjected to a fair trial during the next apparition of *Jupiter*, further details and improvements may be brought forward, should the method be thought worthy of general adoption.

"It would, of course, be highly desirable that the same mode of observation should be pursued (in respect at least of *one* instrument and observer) at the principal observatories, whose longitude is accurately settled, as the results thus obtained would have great influence in determining the question of its practical utility.

"I need not dwell on the importance of distinctly specifying the *atmospheric circumstances* under which these observations are made, as otherwise it will be impossible to judge of their comparability. It might also conduce to further improvement of the method, if the planet's *hour-angle* or *estimated altitude* were recorded, and it would be convenient were the same *denomination* of time employed in registering the observations; or if both the sidereal and mean time were given, as in the Greenwich Observations.

"Should this subject be found to possess sufficient interest to engage a few careful observers in thus watching for the eclipses of *Jupiter's* satellites during the present year, the results might be communicated to the Society, so as to appear in one of their *Monthly*

Notices during the session of 1834; and thus evidence would be had, at one view, of the degree of advantage to be expected from the adoption of such a plan of simultaneous and uniform observation."

XI. Description of a Double Reflecting Circle, and of a Quadruple Reflecting Sextant, made by Mr. Jones, of Charing Cross, under the direction of Captain W. F. Owen, R. N., and presented by the latter to the Society.

The first instrument consists of two parallel circles of reflection, each being a separate reflecting circle, on Troughton's principle, with four indices. These several readings Capt. Owen proposes to reduce to one, by a table exhibiting all the corresponding readings at every degree for 140° on each side of zero.

When each circle is used independently, the instrument differs in nothing from Troughton's reflecting circle; when the two are used together, they are capable of measuring the two angles subtended by three objects in the same plane at the same instant. This is done by bringing the right and left-hand objects in contact with the middle one. If the middle object is wanting, the contact of the other two can be made. Such an arrangement also admits of small angles being measured on many parts of the divided scales, and thus destroys the errors of division.

The instrument was constructed for the purpose above mentioned, of measuring the angles between three objects, which is a problem of extensive utility in sea-surveying. It also measures altitudes in low latitudes, when they are beyond the limits of the sextant or circle. By this instrument, also, the angular distance is measured between the two opposite horizons, and the value of the apparent dip thus obtained, which Captain Owen has observed to differ considerably from that in the tables, from the effects of terrestrial refraction.

A quadruple reflecting sextant (also by Jones) was presented on the same occasion, by Captain Owen. This instrument measures four angles at once, and is designed for similar purposes with the preceding, whose principles it in part combines.

XII. Transits of the Moon with Moon-culminating Stars observed at Cambridge Observatory, in the months of March, April, May, and June, 1833.

Day.	Name.	Clock Time of Transit. h m s	Clock's losing rate. s
March 4.	q Cancri	9 9 30,90	+2,15
	δ Leonis	9 27 41,01	
	Moon 1 L	9 58 7,41	
	ϵ Leonis	10 23 52,71	
6.	ξ^1 Virginis	11 36 27,97	1,86
	Moon 2 L	12 0 51,67	

Day.	Name.	Clock Time of Transit. h	m	s	Clock's losing rate. s
April 1.	37 Leonis	10	6	53,06	+ 2,12
	42 Leonis	10	12	1,43	
	Moon 1 L	10	29	51,59	
3.	b Virginis	11	50	30,37	2,05
	c Virginis	12	10	58,80	
	Moon 1 L	12	25	30,46	
	γ Virginis	12	32	18,83	
28.	η Leonis	9	56	25,01	2,28
	Moon 1 L	10	7	28,38	
	ϱ Leonis	10	22	12,53	
May 3.	$\varkappa$ Virginis	14	4	1,02	2,19
	2 Libræ	14	14	28,33	
	Moon 1 L. (ragged)	14	46	11,42	
	Moon 2 L	14	48	26,18	
	γ Libræ	15	26	12,92	
May 4.	α^2 Libræ	14	41	38,17	2,17
	γ^1 Libræ	14	57	18,44	
	γ Libræ	15	26	10,65	
	Moon 2 L	15	43	33,62	
28.	η Virginis	12	10	27,62	2,24
	Moon 1 L	12	38	1,30	
	k^1 Virginis	12	50	9,57	
	k^4 Virginis	12	54	24,46	
29.	Moon 1 L	13	30	55,61	2,30
	$\varkappa$ Virginis	14	3	3,74	
30.	$\varkappa$ Virginis	14	3	1,59	2,34
	Moon 1 L	14	23	54,06	
	μ Libræ	14	39	12,54	
	ξ^2 Libræ	14	46	44,85	
31.	Moon 1 L	15	17	36,67	2,20
	η Libræ	15	33	41,00	
June 29.	Moon 1 L	16	47	46,49	2,44
	D. Ophiuchi	17	32	17,90	

*** *This number closes the second volume of the Monthly Notices; an Index to which is in preparation, and will accompany the first number of the next volume.*

J. Moyes, Castle Street, Leicester Square.

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